"A STUDY OF GENETIC PARAMETER IN WHEAT (*Triticum aestivum. L. em. Thell.*)"

THESIS

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C E R T I F I C A T E

I hereby certify that the thesis entitled " A Study Of Genetic Parameter In Wheat (*Triticum aestivum*(L). *em. Thell*)", submitted to the Bundelkhand University, Jhansi, for the degree of master of science in Agriculture (Genetics and Plant Breeding), is a record of bonafied research work carried out by Shri Lakshman Singh, Roll No. 16409 under my supervision, during the session 1991-92.

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GLOSSARY

C.F.	Correction factor
Cm.	Centemeter
D.F.	Degree of Freedom
Gms.	Grams
M.S.	Mean sum of squares
M.S.P.	Mean sum of Product
N.	Number of observation
r.	Number of replication
rg.	Genotypic correlation coefficient
rph.	Phenotypic correlation coefficient
re.	Environmental correlation
S.P.	Sum of Product
S.S.	Sum of square
V.R.	Variance ratio
X.	Characters
Y.	Yield
*	Significant at 5% level

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CHAPTER I

INTRODUCTION

Among cereals crops, wheat(*Triticum aestivum*(L.) em. Thell) belonging to the family gramineae is one of the most important of the temperate region of world. It is an important staple food of many in the world.

The major wheat growing countries are U.S.S.R., China, U.S.A. and India. In the world map of its cultivation, India ranks fourth in area(23 million hectare) and production (53.99 million tonnes) during 1989-90). Much of area of in India is concertrated in mostly Utter Pradesh, Madhya Pradesh, Punjab Bihar, Rajsthan, Haryana, Maharashtra and Gujrat. The state Utter pradesh has contributed maximum average production(22.5%) during 1988-89 among all the major wheat growing states of India.

Among three cultivated species of wheat in India bread wheat(*Triticum aestivum*(L.) em.Thell) has its first rank both in area(nearly 80 percent) and production(nearly 90 percent) comparing the hectare yield of analogous wheat growing tracts of the world. It is found that our yield are about the lowest (15.30 quintal per hactare) as against U.S.A.(22.00 quintal per h

and U.S.S.R.(17.00 quintal per hac.) and China(14.00 quintal per hactare), respectively. This is largely due to harizontal expansion in area for getting additional production rather the same goal through a vertical growth in productivity by improving by improving all as reck of Agriculture management.

Rapic advance in Breeding superior bread wheat were made in India during 1963-66.When maxiean varieties Lerma Raja 64-A.and Sonara 64,were introduced in India with the help of Dr. N.E. Borlaug. The bulk meterial of segregating population obtained from Maxico were further subjeeted selection and also utilized in breeding programmes with indegenous wheat cultivars.

The wheat revolution in India standard with the release of dwarf wheat 1966-67 whin the new agriculturaal straegy was adopted.

During the seventees so far, the out put has increased by 47%. This is largely due to striking grains in productivity expemsion in area under high yielding varieties. These are enough possibilities of a quantum jump by accurating its yield potential through genetic manipulation after the introducing of dwarf wheat in India. Attempts have been made to evolve a number on genotypic either directly or through crossing programme.

The average yield of wheat in India is about(21.91 quintal per hactare) which is considerably low. It is there for necessary to improve productivity per hactare.

An under standings of the nature and magnitude of Character association is descrable to achieve a rational improvement incomplex character like yield. An yield is influenced by a number of its components. Therefore selection for higher yield should be based on its components characters rather the yield alone(Graffian, 1960). Although knowledge of the correlation play us veryimportant role in gruding selection strategy but it become ambioguous, if number of variable are more. In such a situation it is essential to partition the correlation coefficient in to components of direct and indirect effect in order to provide the relative importance of the causal factors. Under such situation path coefficient analysis developed by wright(1921) is the only readily available tool in the hands of breeding which measure the actual contribution of such characters.

Keeping in view the above consideration the present investigation"A study of Genetic Parameter in wheat(Triticum aestivum (L.)Em. Thell)" was therefore under taking to make an

intensive study on the following aspects.

1. To estimate the genotypic and phenotypic variabilities.

2. To determume the nature and magnitude of genotypic and phenotypic correlation coefficient between yield and its contributing characters and among the characters them selves.

3. To identify the characters which have direct and indirect breeding on grain yield with help of path analysis.

4. Heritability and Genetic advance.

5. To determine simple correlation.

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CHAPTER II

REVIEW OF LITERATURE

CORRELATION STUDIES :-

A knowledge of nature of association between yield and its component and between various components is of greatest and in plant breeding. The extent and direction of association is measured by correlation coefficient. Correlation studies provide information that selection forone character will result is a progress for all positively correlated because of mutal association. Positive or negative with considered in the correlation studies. These indirect correlation becaruse more complex.

The original concept of correlation was presented by galton(1989) and later elaborted by Fisher(1918,1936) and write (1921). Smith(1953)Kinka & Jain(1928) have applied genetic correlation in wheat. Several workers have reported phenotypic genotypic and inviromental correlation between different pairs of economic charerters.

The knowledge of genetic correlation among economic character and other traits help to improve the effeciency of selection by use of favourable combination of characters and to minimues the regarding effect of negative correlations.

The correlation studies help the breeder during selection. The association is exeressed as(r) which is calculated by statistics method. Broadly speaking the correlation may be classified in to three types i.e.phenotypic, genotypic and environmental.

(1) Genotypic correlation :-

The inheront association between anytwo character would become apparent by the study of genetic correlation. The genotypic correlation remain unaltered by the enviromental condition. This is the type of correlation which would be help ful to a breeder as it would be possible to bring about a change in one character by selecting the other character of a pair that is genotically correlated.

(2) Phenotypic correlation :-

It is that correlation between any two traits which is observable. It includes both the genotypic and environmental effects and hence it differ under different conditio

(3) Environmental correlation :-

The correlation which is entirely due to environmental effect is called the environmental correlation. It is not of much importance to a breeder.

CO-RRELATION STUDIES IN WHEAT :-

Review of the work done related to correlation on this crop is being felonging appended below.

Chinay(1947) reported relationship of yield sith number of karness per spike and average weight of grain per ear.

Sukka and Jain(1958) observed significant positive correlation of ear length, number of grain per ear and plant height with grain yield in wheat. They found that an increase in these with raits may considerable increasethe grain yield.

Harrnald(1960) observed significant and positive correlation between protein content and data maturity.

Ghawas and Elian(1961) found positive correlation of plant yield with plant height strow weight, number of spikelet per ear and number of grain per ear.

Sikka and Singh(1962) reported positive correlation between yield and grain weight.

Donald et.al.(1965) reported that an increase in protein content results in flour with better barking quality. The highly significant correlation between portein and breed grain and texture showed that portein content may be used as a critersian for selecting lines with superior grain and texture.

Cho and Nat sumato(1969) observed a negative correlation of protein with grain yield.

Aulakh and Virk(1973) observed that phenotypic correlation coefficient were positive among yield components except 1000 grain weight, grain yield should a positive and significant association with 1000 grain weight, grain per spike spikelat per spikes and spikes per plant path coefficient analysis should that the positive and the high correlation of 100 grain weight with yield resulted from the direct influence of the farmers. while its effect through characters were negative. All other on each other and thus could be used in selection.

Barriga(1974) observed that spike per plant and ear lias were positively correlated with yield . Number of spikets per plant was positively correlation with ear lines and grain per spike was positively correlated with height but negative 1000 grain weight, number of grain per spike. 1000 grain weight had a strong positive direct effect on yield, but ear lines and plant height had were effect, negative and positive respectively The first there characters thus considired as the principal yield component and next two as secondary.

Dunder(1974) observed positive correlation of yield with productive tillering grain weight per ear, grain per ear. grain weight per ear was found to be indirect correlation with grain per ear and 1000 grain weight.

Kumar(1974) noted that correlation between protein content and sedimentation value was high and positive.

Jaimini et.al.(1974) observed significant and positive correlation of grain yield with spike per plant, spikeelets per spike and 1000 grain weight and negative correlation with days to heading.

Randhawa et.al.(1975)observed the positive significant genotypic and phenotypic correlation between grain yield and peduncle length.

Jain and Singh(1975). Revealed that in the three gene dwarf group. Only extrusion length and 1000 grain weight were correlated significantly and positively with yield. In two gene dwarf group, grain weight was associated positively and significantly with to flowering and spikelets per ear.

Mikheev et.al.(1975). Observed a close correlation between grain per ear and yield and moderate correlation between, 1000 grain weight and yield the correlation between ear and yield was low.

Sidewell et.al(1976). Observed high phenotypic and intermidate genotypic correlation of grain yield with tiller number and intermidate to low with and grain weight and grain per spike negative. Association was found for grain weight with tiller number and grain weights.

Jain et.al.(1976). Observed a significant positive correlation between seed size and the protein content of the seeds.

Chaubey(1977). Studied character relationship and effectiveness of early generation selection for chapati making quality in bread wheat. Chapati scope was potively and significantly correlated with sedimentation value grain hardness work of deformation mixing line stability and strength and negatively with phenon ratio. Grain hardness and phenol ratio could advantageguasly be used screeng populations for improving chapati making quality.

Law et.al.(1978). Showed that yield per paltn and plant height were positively correlated.

M.C.Neel et.al.(1978). observed that kernel weight and kernel per spike were very good traits for indirect selection for yield improvement

Moss(1978). Observed that hard grained variety give the most desirable variance of hardness with protein high protein levels where as softer varieties a did show that olower protein level.

Tarutinav et.al.(1978). The result are given of analysis of correlation between 13 quantitative characters in light spring wheat varieties the closest positive correlations were between grain weight per plant and such characters as grain weight as a percentage of total plant weight.

Hrich(1979). Reported a significant negative correlation between 1000 grain weight and grain protein content.

Yadav and Murty(1979). Reported yield per plant was significantly correlated with ear per plant spikeelet per ear and 1000 grain weight Devendra Singh and Mahendra Singh(1979) study that 1000 grain weight and grain number shoot had direct positive effect on yield.

Luthara et.al.(1979). Studied that grain yield was spiks per plant were the main contributing characters to harvest index, where as bilogical yield was nigatively correlated with harvest index.

Shukene et.al.(1979). Studied thatprotein content was positively correlated with 1000 grain weight.

Edwards and Thompson(1980). Observed a negative but weak correlation on between yield and protein concentration.

Pandey(1980). Observed significant desirable association of grain yield with protein content and test weight where as negative inter-relationship was observed between grain yield and tryptophan content.

Dimistriew et.al.(1980).Observed that yield was most colsely correlated with productive tillers, grain weight per ear 1000 grain weight and grain set per ear.

Shek(1980). Found most grain stable positive correlation between yield and grain weight per ear. yield and number of grain per ear. One further noted a weak positive correlation between grain weight per ear and 1000 grain weight.

Virk(1980). Observed highly significant and positive association with plant height, ear length, tiller per plant and number of grain per spike.

Kumar and Nikiforva(1981). Reported that hardness was closely correlated with first class flower and irrigation had no effect on grain hardness.

Chaik(1982). revealed that protein content was negatively correlated with yield.

M.C. Neal et.al.(1982). reported that grain yield was negatively correlated with yield protein percentage but it was

positively correlated with protein yield.

Raina et.al.(1982). Stated that number of grain per spike and 1000 grain weight showed a negative correlation with each other but positively correlated with grain yield per plant, grain yield was negatively corrlated with protein content. They observed a positive correlation of test weight with protein content. petshanke value and lycine content.

Sompson(1982). Reported no correlation between grain association to commercial varieties.

Mitra and Bhatia(1984). Observed that the rates of flages senescense and N loss were positively percentage and negatively correalted with grain yield.

Singh and Awasthi(1984). Observed significant positive correlation of grain yield with plant height, number of effective tillers, ear length, ear per plant, grain weight per ear and 1000 grain weight.

Sharma et.al.(1984). Found positive and significant association between harvest index and grain yield.

Mirkheev(1985). Observed a close relationship between grain per ear and yield and moderate correlation between 1000 grain weight and yield weight. The correlation between ear and yield was low.

Sandha et.al.(1985). Reported significant positive correlation between grain yield and productive tiller and grain

yield and length of spike.

Lasnichuk et.al.(1985). From data(tabulated) obtained in 1978-83 in the forest stage of the ukrine on productive tillers /m^2, grains /ear, weight of grain per ear,and 1000 grain weight correlation were established between these components and yield. The highest and most stable correlation was between and grain weight per ear.

~~Kumar and Chaudhary(1986)~~ Nachit and Jaran(1986). Found that plant height peduncla length and tillering score were positively and significantly correlated with yield.

Dutta et.al.(1986). various correlation are reported among grain yield plant and yield characters recorded for 6 Triticum aestivum varieties grain yield per plant was highly and positively corrlated with 100 grain weight.

Adary and phady(1987). Observed a positive correlation of grain yield with number of ear per plant unit area, grain per ear and no. of heading.

Chaubey et.al.(1987). Observed that chapati score was significant and positively correlated with grain hardness, estability and strength.

Kahn et.al.(1987).Reported that protein content was significantly and positively correlated with dough development time.

Pinthus(1987). Stated that there was no association between mean grain weight and grain yield/hectare.

Seakyan(1987). Madea study on short and tall variety under different sowing regions and observed a high and stable correlation between grain weight and number per ear. while low correlation of 1000 grain weight with grain weight and grain number per ear had been observed.

Singh et.al.(1987). Found a high and consistant positive association of grain yield with total tiller number and grain per ear.

Krotova (1988). Reported that yield per plant was closely correlated with number of tillers and yield of the main ear. They observed a high and significant correlation of yield per main ear with number of grains per main ear and grain size.

Srivastava et.al.(1988). Observed a significant and positive correlation of yield with harvest index biological yield grain weight per spike, spike per plant. They found that above characters except biologicla yield showed positive and significant correlation with harvest index and only positive correlation among themselves.

Endaie and Wainee(1989). Reported a negative correlation of plant height with number of grain per head 1000 grain weight grain yield and harvest index observed a significant negative

genetic correlation between number of heads per plant and number of grain per heads 1000 grain weights and harvest index was negatively associated with days to maturity .Plant height number of heads per plant and straw yield and positively c correlation with number of grain heads 1000 grain weight and harvest index.

Hadrichri stodau (1989). Computed environmental correlation coefficient of five traits namely grain yield, heading date, number of tiller per plant, height and 1000 grain weight and reported a significant correlation of grain yield with the other four characters.

D.P.Saini et.al.(1990). reported grain yield exhibited a high order of positive and significant correlation with the ear number per plant and biological yield in all the crosses and enviroments However it showed a low positive and negative correlation respectively, with maturity and harvest index . The association of grain yield with other traits very with enviroment and crosses.

Zhao et.al.(1991).Information on yield correlation is derived from data on 7 quantitative traits including grain weight per spike and grain yield in 37 wheat variety and there F_1 hybrids.

Collaku,A(1991). Reported on the basis of a study of yield and 6 related traits in 42 lines and there 5 parents. Correlation between traits are indicated and the result are given

given of a path analysis of the data obtained. The main yield componentes was 1000 grain weight, which accounted for 20.2 % of variation in yield, no. of spike per ear for 5% variation was also important. It is thought that indirect selection for yield on the basis of there 2 traits would be effective.

Loskutov, I.G.(1991). Computed the coefficient of correlation between yield and grain number per ear on average over 3 years was 0.35 in early and 0.44 in midlate variety. The yield was more closely correlated with 1000 grain weight. In late varieties yield was correlated with grain number per year (r= 0.49) and 100 grain weight(r= 0.38).

Raut,S.K. Khorgade(1991). Information on yield correlation is derived from data on 8 yield components in 32 genotypic growing during season 1985-86. Data on partial coefficient indicated that the grain yield was mainly depended on productive tillers per plant, spikelet per spike, grain per spike and 100 grain weight.

Hatwar et.al.(1991). Information on yield correlation is derived from data on 11 yield components in 3 varieties growing during 1984-86 with 4 source of N at 4 levels.

PATH COEFFICIENT ANALYSIS :-

Path coefficient analysis was originally alloeated by wright,(1921) for estmation of direct effect of the characters on yield and indirect effect of the same through yield contributing factors. Direct effectes are considered to be independent of the interrealtionship among the variables and provide direct measure of the associationship between the dependent and independent variables. Indirect effects of the characters on yield and its intensity of indirect effect on yield through other attributes the literature avilable for this technique described belsow.

Virach and Singh(1972). Carried out that path analysis for yield and found that grain yield was positively correlated with plant height, year per plant and 1000 grain weight and concluded 1000 grain weight had the important influenced on yield.

Chaudhary et.al.(1977). Reported that the highest direct effect on grain yield on harvest index followed by plant height and total days to maturity. Yield also effected harvest index directly through grain yield, ear length and plant height.

Ahmad et.al.(1978). Studies path coefficient analysis and observed that 1000 kernal weight from component traits and early

early groth vigour from developmental traits were the only attributes for which selection is effective in both the generation.

Kumbhar et.al.(1981). Studied direct and indirect of flour yield components on grain yield and observed that numberof grain per spike had most impotant effect on yield.

Kudzelka et.al.(1985).Studied 4 varieties and found a high direct effect of grain number per ear. 1000 grain weight on grain weight per ear. Positive indirect effect of ear length, number of spikelet per ear on grain weight per ear via grain number of per ear.

Kozlovskaya and Milnik(1985). Reported that the weight of grain from the main year was the main characters affecting the yield.

Jatasra and Paroda(1985). Discovered the greatest direct effect of tiller per plant on yield. While grain weight per ear and syncyony of height were other important yield component.

Pathak et.al.(1986). Genotypic and phenotypic correlation of 5 yield components with yield per plant and their path coefficient are tabulated for group of is cultivers grown in the field under heat stress and froght. There was significant variation among the genotypic for all the traits studies. Grain

weight per ear, plant height and ear length and showed high genetypic correlation with yield, grain weight per ear had the greatest direct effect on yield(determened by path analysis) and is considered an important traits in selecting for resistant to heat and drought it was followed by number of effective per p plant.

Singh et.al.(1987). Reported that total biomers had a considerable positive direct effect on grain yield and indirect effect on grain yield through tiller number and grain per ear.

Shamsuddin (1987). Carried out a study in 30 varieties grown during the winter season and revealed that spikes per plant glumes per spikes, 1000 grain weight, glume weight per plant(G) biological yield and harfest index were directly related to yield per plant and flage area was indirectly related to yield per plant and through biological yield and(G).

Jadav and Jadav(1987). found greatest direct effect of tiller per plant and grain weight per spike of yield.

Shrivastava et.al.(1988). Studied path analysis in 67 genotypic and conducted high direct effect on yield through biological yield harvest index grain filling period and days to maturity were also observed on harvest index. The other components traits had moderate direct effect on grain yield and harvest index.

Ehdaie and Waines(1989). computed positive direct effect on yield throughdye days to maturity. Plant height number of head per plant, number of grain per head, 1000 grain weight and harvest index. Days to maturity and plant height exhivited the highest and lowest direct effect respectively. The positive direct effect of days to maturity, plant height and number of head per plant, however partially or completly counter balance by their, strong negative effect through number of grain per head, 1000 grain weight and harvest index.

Ahmad et.al.(1990). Reported high heritability for 1000 grain weight, harvest index and phenol reaction, genetic advance in percent over mean was high for 1000 grain weight.

Patil H.S. and Narkhede, B.N.(1990). Information on yield correlation and genetic advance is derived from data on 8 characters in 36 genotypes grown during rabi 1985-86.

Kuldeep singh et.al.(1991). Data on yield 3 yield components and harvest index were recorded for 6 varieties. Additive dominance and epistatic effect were found for all characters.

VARIABILITY AND HERITABILITY :-

Botezen et.al.(1978). Reported that data of heading was closely correlation with grain weight per ear . Height and correlation contribution to yield was made by 1000 grain weight.

Dimistriew et.al.(1980). Observed that yield was most closely with productive tillers, grain weight per ear, 1000 grain weight and grain set per ear.

Shamma et.al.(1985). DAta on grain yield and 7 yield related character were recorded for the departmental progenies and correspondings P_3 lines from F_2 of a triticala cross grown in brought shressed and non stressed environments. Grain yield was highly influenced by genotypic enviromental interaction in both generation. The other character were influenced to rarious extents by the interaction.Narrow sense heritability was moderate for plant height ear length spikelate number and grain size under both enviroments but low for the other characters.

Khan et.al.(1985). Data presented on the coefficients of variation expected genetic advance and heritability for yield per plant and relative characters in the 12 varieties. All the traits were quantitatively inherited broad sence heritability estimate were generally moderate to high often combiend with a high value of expected genetic advance.

Pawar et.al.(1989). Information on heritability and variability was derived from data on 8 yield components in 3 lines and three croses between them grown during 1981-82.

Thakur et.al.(1989). Information on genetic variability and yield correlation is derived from data on 7 yield components in 10 genotypes and their F_2 hybrids.

Atale and Vitkare(1990). Reported the range of parental variation was substantial for ear length, ear weight, grain weight per ear and 1000 grain weight which is indicated of the fact that parent have sufficient gnetic diversity.

K.A. Nayeem and Garshin(1990). Reported the genetic variability, phenotypic, genotypic coefficient variation heritability and genetic advance were estimate. Considerable amount of phenotypic and genotypic variabilities was observed. All the groups of crop have high magnitude of genetic variabili ty, high heritability and moderate genetic advance indicating that importance should be given selection programme.

Singh et.al.(1990). Information on combining ability was derived from data on grains per spike, 1000 seed weight and grain yield in 9 diverse, induced stable mutants the parental variety and their crosses.

Tsenov(1990). Reported in a study of purrents. Heritability estimate were mderate(heritability = 0.47, range 0.38-0.52) and cultivation condition played an important part. Although same plants with profuse tillering inheritated from plisk were selected.

Verma et.al.(1991). Information on genotypic variabilities and heritability is derived from data on yield and 5 related characters in back croses grown during 1980-81.

Xie and Zhang Z.H.(1991). Information on heritabilities derived was from data on several yield components. Includeing grain number per ear, 1000 grain weight, stam length and ear lines in 9 wheat croses grown during 1980-84.

Thakawale et.al.(1991). Information on genetic variance and yield correlation was derived from data on 7 yield components in 54 varieties grown in 1984.

Kheiralla(1991). Informationon that heritability, genotypic and phenotypic coefficient of variability, expected genetic advance and yield ~~was~~ correlation was derived from data on 6 yield components this information was used to asses the grains in grain yield by 1direct and two indirect selectionmethods. Generally direct single traits selection proved that most effected method.

Oliveiro Camargo(1991). Reported that the narro sense heritability for plant height were moderately(0.43 - 0.48) and high for same varieties. Moderate value were estimated for number of ears per plant. heritability values for 100 grain weight were low. The phenotypic correlation between grain yield and ear per plant, plant height, grains per ear and 100 grains weight were positive and mostely highly significant. The result suggested that it would be possible to select semidwarf plants, with high yield potential a high number of grain per ear per plant and a high 100 grain weight. If large segregating population are used to identify desired genotypes.

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CHAPTER III

METERIALS AND METHOD

MATERIALS :-

Thirteen(13) varieties of wheat(*Triticum aestivum*.L.) was brought for the present investigation on the basis of their genetic diversity. They had been obtained from the Depth. of Genetics & Plant Breeding C.S.A. University of Agriculture and Techonology Kanpur U.P. All the thirteen varieties have been shown in the following table no. 1

TABLE NO. 1

S.N.	Varieties	Symbol used
1.	G W - 234	1
2.	PBW - 321	2
3.	MP - 942	3
4.	GW - 232	4
5.	WH - 147(c)	5
6.	D L - 765-1	6
7.	Raj- 3783	7
8.	H D - 2630	8
9.	G W - 230	9
10.	Raj- 3785	10
11.	Raj-3786	11
12.	H I - 1383	12
13.	G W -231	13

METHODS :

(A) Field lay out :

The material was sown in the complete randomized block dedign with 4 replication on December 4, 1991. Each Treatment was sown in plot of 6 raws each 6 meter long & spaced 23 cm. apart. An approximate spaced of 5 cm. between the plant was maintained. The experiment was conducted at the college farm of Brahmanand Post Graduate College, Rath(Hamirpur) U.P.

(B) Characters Studied :

The data on the following characters were recorded on 5 Randomly chosen plants. In all 260 plants were studied. The selected plants were tqgged with proper information for identification and border rows were exhaused from the experiment. During selection however the diseased and abnormal plants were avoided.

(I) Days to flower(X_1) :

Sowing date to flower data.

(II) Height of plant(in centimeter)(X_2)

The height of plant was recorded in centimeter from the ground level to the top of the plant.

(III) No. of tillers per plant(X_3)

All the tillers arising from the same node were counted..

(IV) No. of spikes per plant (X_4) :

All the spikes of selected plant were counted.

(V) Length of spike (X_5) :

The length fo spike was recorded in centimeter.

(VI) Days to Maturity (X_6) :

Sowing date to harvest date.

(VII) No. of seed per spike (X_7) :

The seed of five spikes were counted and had been divided by five.

(VIII) Test weight or seed weight (X_8) :

100 seeds from each plant were counted and weighted in grams for test weight.

(IX) Yield per plant (X_9)

The yield of grain per plant was weighted in grams.

(C) Statistical methods :

(1) Mean:

It is the sum of measurements or observations devided by their number. Thus for each character the observations of 5 plants were averaged in accordance with the following formula.

$$\text{Mean} = \frac{\Sigma X}{N}$$

STEP II :

Calculation of sum of squares :

The sum of square were obtained as follows :

(I) Correction factor (C.F.) $= \dfrac{(G.T)^2}{N}$

(II) Total sum of squares(T.S.S.) =

$$(X_{11}^2 + X_{22}^2 + \text{----------} + X_{mn}) - C.F.$$

(III) S.S. DUE TO Replication $= \dfrac{(R_1^2 + R_2^2 + \text{--------} R_n^2)}{\text{No. of treatment}} - C.F.$

(IV) S.S.due to treatment $= \dfrac{(T_1^2 + T_2^2 + \text{----------} + T_n^2)}{\text{No. of replication}} - C.F.$

(V) S.S.due to error = T.S.S. -(Replication S.S.+ Treatment S.S)

STEP III :

The sum of squares were arranged in the following table(3) to test the significance of difference between treatment.

TABLE NO. 3

The sum of squares were arranged in the following table to test the significance of differences between treatments.

S.N.	Source	d.f.	S.S.	M.S.S.	V.R.
1.	Replication	(R-1)	r	V_r	V_r/V_e
2.	Treatment	(T-1)	t	V_t	V_t/V_e
3.	Error	(R-1)(T-1)	e	V_e	
Total		(TR-1)			

If the variance ratio(vt/ve) for treatment is lesser than the table value of 5% level of significance of the difference between treatment are considered to be not significant at vaice-versa.

Components of variance :

Conceding that all varieties tested have were genetically uniform the expected mean sum of squares for error (M.Se.) .i.e. σ^2e will be purely random environmental varieties. The mean sum of squares between varieties will consult of the variances.

(I) Attributable to varietal differences(Genotypic differences) and

(II) Due to environment.

variation among indivisual of genotypic. Thus the expected mean of sum of squares would be follows :-

$$E(M.S_v) = \sigma^2e + r\,\sigma^2g$$

$$E(M.S_e) = \sigma^2_e$$

$$\text{There fore, } \sigma^2_g = \frac{M.S_v - M.S_e}{r}$$

$$\text{Phenotypic variance } (\sigma^2p) = \sigma^2g + \sigma^2e$$

TABLE NO. 4

S.N.	Character	$\sigma^2 g$	$\sigma^2 e$	$\sigma^2 p$
1.	Days to flower			
2.	Height of plant			
3.	No. of tillers per plant			
4.	No. of spikes per plant			
5.	Length of spikes			
6.	Days to maturity			
7.	No. of seed per spike			
8.	100 seed weight			
9.	Yield per plant			

(a) Genotypic coefficient of variation were calculated as follows:

$$(G.C.V.) = \sqrt{\frac{\sigma^2 g}{\bar{X}}} \times 100$$

(b) Phenotypic coefficient of variation (P.C.V.)

$$(P.C.V) = \sqrt{\frac{\sigma^2 p}{\bar{X}}} \times 100$$

(c) Heritability(Broad sence) :

It was the ratio genotypic variance to Phenotypic variance and the formula as follows :-

$$h^2 = \frac{\sigma^2 g}{\sigma^2 p}$$

where $\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

(d) Genetic advance :

For estimating the expected genetic advance in a characters through selection index the formula suggested by Robinson et.al(1951 was applied.

$$\text{Genetic advance (G.A.)} = \frac{gww}{\sqrt{pww}} \times K$$

$$\text{or} = \frac{\sigma^4 g}{\sqrt{\sigma^2 p}} \times K$$

Where,

gww or $\sigma^2 g$ = Genotypic variance of w

pww or $\sigma^2 p$ = Phenotypic variance of w

K = Selection intensity at 5% level(2.06)

w = Chosen character

(3) ANALYSIS OF COVARIANCE :

The method of calculation differents sum of products is given below.

(1) Correction factor(C.F.) $= \dfrac{GT(X)\ .\ GT(Y)}{N}$

(II) Total sum of products(T.S.P.) =

$$=(X_{11}Y_{11}) + \text{-----------} + (X_{m\,n} \cdot Y_{m\,n}) - C.F.$$

(III) Replication S.P.= $\dfrac{(R_1X \cdot R_2Y) + \text{-------} + (R_{m\,n}X \cdot R_{m\,n}Y)}{\text{No. of treatment}} - C.F.$

(IV) Treatment S.P. = $\dfrac{(T_1X \cdot T_1Y) + \text{--------} + (T_mX \cdot T_mY) - C.F.}{\text{No. of Replication}}$

(V) Error S.P. = T.S.P - (R.S.P. + Tr.S.P.)

COMPONENTS OF COVARIANCE :

Expectation of mean of wum of products follows the same principles as those mean sum of squares.

Thus :-

$$E(M.SP_v) = 6\,e_1 \cdot e_2 + r\,g_1 \cdot g_2$$

$$E(M.SP_e) = 6\,e_1e_2$$

Hence :-

$$6^2g_1\,g_2 = \frac{M.SP_v - M.SP_e}{r}$$

$$6^2p_1p_2 = 6^2\,g_1g_2 + 6^2\,e_1e_2$$

These components were calculated and were summensed in the following table no. 5

TABLE NO. 5

S.N.	Characters	Components		
		$\sigma^2 g_1 g_2$	$\sigma^2 e_1 e_2$	$\sigma^2 p_1 p_2$
1.	Days to flower VS Height of Plant (X_1X_2)			
2.	Days to flower VS no.of tiller per plant (X_1X_3)			
3.	" " " VS no.of spike per plant(X_1X_4)			
4.	" " "VS Length of spikes(X_1X_5)			
5.	" " "VS Days to maturity(X_1X_6)			
6.	" " "VS no.of seed per spikes(X_1X_7)			
7.	" " "VS 100 seed weight(X_1X_8)			
8.	" " "VS Yield per plant(X_1X_9)			
9.	Height of plant VS no. of tillers per plant(X_2X_3)			
10.	Height of plant VS no.of spike per plant (X_2X_4)			
11.	" " " VS Length of spikes(X_2X_5)			
12.	" " " VS Days to maturity(X_2X_6)			
13.	" " " VS no.of seed per spikes(X_2X_7)			
14.	" " " VS 100 seed weight(X_2X_8)			
15.	" " " VS Yield per plant(X_2X_9)			
16.	No.of tiller plant VS no.of spike per plant(X_3X_4)			
17.	" " " VS Length of spikes (X_3X_5)			
18.	" " " VS Days to maturity (X_3X_6)			
19.	" " " VS no.of seed per spikes(X_3X_7)			

S.N.	Characters	Components		
		$\sigma^2 g_1 g_2$	$\sigma^2 e_1 e_2$	$\sigma^2 p_1 p_2$
20.	" " 100 seed weight (X_3X_8)			
21.	" " " VS Yield per plant(X_3X_9)			
22.	No.of spikes per plant VS Length of spike(X_4X_5)			
23.	" " " VS Days to maturity(X_4X_6)			
24.	" " " VS no.of seed per spike(X_4X_7)			
25.	" " " VS 100 seed weight(X_4X_8)			
26.	" " " VS Yield per plant(X_4X_9)			
27.	Length of spike VS Days to maturity(X_5X_6)			
28.	" " " VS No.of seed per spike(X_5X_7)			
29.	" " " VS 100 seed weight(X_5X_8)			
30.	" " " VS Yield per plant(X_5X_9)			
31.	DAys to maturity VS no.of seed per spikes(X_6X_7)			
32.	" " " VS 100 seed weight(X_6X_8)			
33.	" " " VS Yield per plant(X_6X_9)			
34.	No. of seed per spikes VS 100 seed weight(X_7X_8)			
35.	" " " VS Yield per plant(X_7X_9)			
36.	100 seed weight VS Yield per plant(X_8X_9)			

CORRELATION :-

(I) Correlation were calculated using the following formula:-

$$r(X_1X_2) = \frac{Cov\ X_1X_2}{\sqrt{V(X_1) . V(X_2)}}$$

Where

$r(X_1X_2)$ is the correlation between X_1 and X cov.

(X_1X_2) is the covariance between X_1 & X_2

$V(X_1)$ is the variance of X_1

$V(X_2)$ is the variance of X_2

(II) Correlation coefficient :

The correlation on coefficient between the variables were calculated with the help of this formula :-

(A) Genotypic correlation coefficient :-

It was calculated by the following formula as suggested by Robinson et.al.(1951).

$$\text{Genotypic correlation} = \frac{\text{Genotypic covariance}}{\sqrt{G.V(X) \ . G.V(Y)}}$$

Where:-

G.V.(X)= Genotypic variance for X .

G.V.(Y) = Genotypic variance for Y.

X, Y are two varibles.

(a) Genotypic covariance = $\frac{\text{M.S.P.treat(Xy)} - \text{M.S.P. Error}}{r}$

(b) Genotypic variance of X= $\frac{\text{M.S.S.treat(X)}.\text{M.S.S. Error(X)}}{r}$

(B) <u>Phenotypic correlation coefficient</u> :

It was calculated by the following formula suggested by Robinson et.al.(195)

$$\text{Phenotypic Correlation} = \frac{\text{Phenotypic covariance}}{\sqrt{\text{Ph.V. for(X)} . \text{phe.V.for(Y)}}}$$

where

Ph.V for X = Phenotypic variance for X

ph.V for Y = Phenotypic variance for Y

X & Y are two variables

(a) Phenotypic covariance = $\frac{\text{M.S.P. Treat(XY)}}{r}$

(b) Phenotypic variance of X = $\frac{\text{M.S.S. Treatment (X)}}{r}$

(c) Phenotypic variance of Y = $\frac{\text{M.S.S. Treatment(Y)}}{r}$

(C) <u>Environmental correlation coefficient</u> :

Environmental correlation coefficient(r_e) was determine by the following formula :-

$$re = \frac{\text{S.P. X y}}{\sqrt{\text{S.S.(X) S.S.(Y)}}} \quad \text{(Error lines)}$$

where:

re= Environmental correlation coefficient

S.P.(XY) = Sum of products of XY

S.S.(X) = Sum of squares of X

S.S.(Y) = Sum of squares of Y

X & Y are two variables

TABLE No. 6

SIMPLE CORRELATION :

S.N.	Characters	Simple Correlation
1.	Days to flowers VS Height of plant(Cm)	r_{12}
2.	" " " " VS No. of tillers per plant	r_{13}
3.	" " " " VS no. of spikes per plant	r_{14}
4.	" " " " VS Length of spikes	r_{15}
5.	" " " " VS Days to maturity	r_{16}
6.	" " " " VS No.of seed per spike	r_{17}
7.	" " " " VS 100 seed weight	r_{18}
8.	" " " " VS Yield per plant	r_{19}
9 .	Height of plant VS no.of tiller per plant	r_{23}
10.	" " " " VS no.of spike per plant	r_{24}
11.	" " " " VS Length of spike	r_{25}
12.	" " " " VS Days to maturity	r_{26}
13.	" " " " VS no.of seed per spike	r_{27}
14.	" " " " VS 100 seed weight	r_{28}
15.	" " " " VS Yield per plant	r_{29}

S.N.	Characters	Simple correlation
16.	No.of tillers per plant VS No.of spike palnt	r_{34}
17.	" " " " VS Length of spike	r_{35}
18.	" " " " VS Days to maturity	r_{36}
19.	" " " " VS No.of seed/ spikes	r_{37}
20.	" " " " VS 100 seed weight	r_{38}
21.	" " " " VS Yield per plant	r_{39}
22.	No.of spikes/plant VS Length of spike	r_{45}
23.	" " " " VS Days to maturity	r_{46}
24.	" " " " VS No.of seed per spikes	r_{47}
25.	" " " " VS 100 seed weight	r_{48}
26.	" " " " VS Yield per plant	r_{49}
27.	Length of spikes VS Days to maturity	r_{56}
28.	" " " " VS No.seed per spike	r_{57}
29.	" " " " VS	r_{58}
30.	" " " " VS Yield per plant	r_{59}
31.	Days to maturity VS No.of seed/ spike	r_{67}
32.	" " " " VS 100 seed weight	r_{68}
33.	" " " " VS Yield per plant	r_{69}
34.	No.of seed VS 100 seed weight	r_{70}
35.	" " " " VS Yield per plant	r_{79}
36.	100 seed weight VS Yield per plant	r_{89}

(V) Test of Significance :

The significant of correlation coefficients was tested with the help of a table(Table VI) statiscal table by(Fishar & Yates). at n-2 degree of freedom.

$$\text{formula} = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

Where

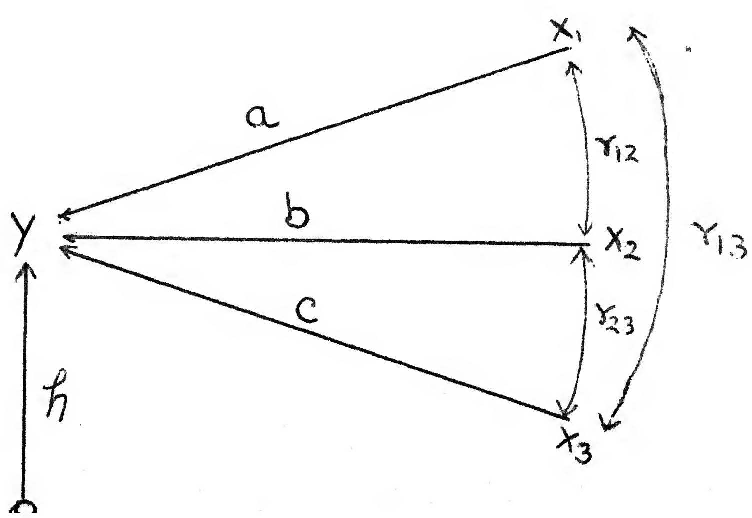
r = Correlation

n = No. of varieties

(VI) Path analysis :

Calculation of Path coefficients :

In the figure abc and h are the path coefficient due to respective variables. Path coefficient can be defined as the ratio of the standerd deviation of the effects due to a given cause to the total standard deviation of the effect i.e. if y is the effect and x_1 is the cause. The path coefficient for the path from cause x_1 to the effect Y is x_1 / y as per definition



$\frac{\sigma X_1}{\sigma y}$ = 'a' The path coefficient from X_1 to Y

$\frac{\sigma X_2}{\sigma y}$ = 'b' The path coefficient from X_2 to Y

$\frac{\sigma X_3}{\sigma y}$ = 'c' The path coefficient from X_3 to Y

Thus, $r(X_1 y) = a + r(X_1 X_2)b + r(X_1 X_3)C$

The correlation between X_1 & Y may be parbational with three parts namely :-

(I) Due to direct effect of X_1 and Y each amount to "a"

(II) Due to indirect effect of X_1 on Y via X_2 which amounts to $r(X_1 X_2)$ 'h'

(III) Due to indirect effect of X_1 on the via X_3 which equals $r(X_1 X_3)$ 'C'

Thus

we get the simultaneous equation :-

$$r(X_1 Y) = a + r(X_1 X_2)b + r(X_1 X_2)\ C$$

$$r(X_2 Y) = r(X_2 X_1)a + b + r(X_2 X_3)\ 'c'$$

$$r(X_3 Y) = r(X_3 X_1)a + r(X_3 X_2)b + e_r\ (R.Y) = h$$

It was used as follows :-

$$h^2 = 1 - a^2 - b^2 - c^2 - 2(XX_2)\ ab\ 23(X_1 X_3)\ ac - 2r(X_2 X_3)bc.$$

The path analysis of eight characters on yield had been calculated the help of simul taneous equation which have been given below:-

1. $r_{19} = \underline{P_{19}} + r_{12} P_{29} + r_{13} P_{39} + r_{14} P_{49} + r_{15} P_{59} + r_{16} P_{69} + r_{17} P_{79} + r_{18} P_{89}$

2. $r_{29} = r_{21} P_{19} + \underline{P_{29}} + r_{23} P_{39} + r_{24} P_{49} + r_{25} P_{59} + r_{26} P_{69} + r_{27} P_{79} + r_{28} P_{89}$

3. $r_{39} = r_{31} P_{19} + r_{32} P_{29} + \underline{P_{39}} + r_{34} P_{49} + r_{35} P_{59} + r_{36} P_{69} + r_{37} P_{79} + r_{38} P_{89}$

4. $r_{49} = r_{41} P_{19} + r_{42} P_{29} + r_{43} P_{39} + \underline{P_{49}} + r_{45} P_{59} + r_{46} P_{69} + r_{47} P_{79} + r_{48} P_{89}$

5. $r_{59} = r_{51} P_{19} + r_{52} P_{29} + r_{53} P_{39} + r_{54} P_{49} + \underline{P_{59}} + r_{56} P_{69} + r_{57} P_{79} + r_{58} P_{89}$

6. $r_{69} = r_{61} P_{19} + r_{62} P_{29} + r_{63} P_{39} + r_{64} P_{49} + r_{65} P_{59} + \underline{P_{69}} + r_{67} P_{79} + r_{68} P_{89}$

7. $r_{79} = r_{71} P_{19} + r_{72} P_{29} + r_{73} P_{39} + r_{74} P_{49} + r_{75} P_{59} + r_{76} P_{69} + \underline{P_{79}} + r_{78} P_{89}$

8. $r_{89} = r_{81} P_{19} + r_{82} P_{29} + r_{83} P_{39} + r_{84} P_{49} + r_{85} P_{59} + r_{86} P_{69} + r_{87} P_{79} + \underline{P_{89}}$

---

where:-

$P \rightarrow$ Path coefficient, $r \rightarrow$ Correlation coefficient

$P_{19}, P_{29}, P_{39}, P_{49}, P_{59}, P_{69}, P_{79}, P_{89}$ are respectively the differents path coefficients due to respecti characters with yield.

$r_{19}, r_{29}, r_{39}, r_{49}, r_{59}, r_{69}, r_{79}, r_{89}$ are the differents correlation coeffieients of different characters with grain yield.

(B) Residual Effects :-

Following formula had been used to determine the residual effects :-

$$P_{R_9} = \sqrt{1-(P_{19}r_{19})-(P_{29}r_{29})-(P_{39}r_{39})-(P_{49}r_{49})-(P_{59}r_{59})-(P_{69}r_{69})-(P_{79}r_{79})-(P_{89}r_{89})}$$

CALCULATION OF DIRECT & INDIRECT EFFECTS :-

The direct & indirect effect of each characters on yield were calculated with the help of correlation of the respective characters with the grain yield.

(1) For days to flower and grain yield(X_1 & X_9)

Direct effect	$= P_{19}$
Indirect effect via Height of plant(X_2)	$= P_{29}r_{12}$
Indirect via no.of tillers per plant(X_3)	$= r_{13}P_{39}$
Indirect effect via no.of spikes per plant(X_4)	$= r_{14}P_{49}$
Indirect effect via Length of spikes(X_5)	$= r_{15}P_{59}$
Indirect effect via Days to maturity(X_6)	$= r_{16}P_{69}$
Indirect effect via no.of seed per spike(X_7)	$= r_{17}P_{79}$
Indirect effect via 100 seed weight(X_8)	$= r_{18}P_{89}$
Total effects(Direct & indirect)	$= r_{19}$

(2) For height of plant(X_2) and yield(X_9) :-

Direct effect	$= P_{29}$
Indirect effect via Days to flower (X_1)	$= r_{21}P_{19}$
Indirect effect via no. of tiller per plant(X_3)	$= r_{23}P_{39}$
Indirect effect via no. of spike per plant (X_4)	$= r_{24}P_{49}$
Indirect effect via length of spike (X_5)	$= r_{25}P_{59}$
Indirect effect via Days to maturity (X_6)	$= r_{26}P_{69}$
Indirect effect via no. of seed per spike (X_7)	$= r_{27}P_{79}$
Indirect effect via 100 seed weight (X_8)	$= r_{28}P_{89}$
Total(Direct & indirect) effect	$= r_{29}$

(3) For no. of tillers per plant(X_3) and yield(X_9) :-

Direct effect	$= P_{39}$
Indirect effect via Days to flower (X_1)	$= r_{31}P_{19}$
" " via Height of plant (X_2)	$= r_{32}P_{29}$
" " via no. of spike per plant (X_4)	$= r_{34}P_{49}$
" " via length of spike(X_5)	$= r_{35}P_{59}$
" " via Days to maturity (X_6)	$= r_{36}P_{69}$
" " via no. of seed per spikes(X_7)	$= r_{37}P_{79}$
" " via 100 seed weight(X_8)	$= r_{38}P_{89}$
Total direct & indirect effect	$= r_{39}$

(4) For no. of spikes per plant(X_4) and yield(X_9) :-

Direct effect	$= P_{49}$
Indirect effect via Days to flower(X_1)	$= r_{41}P_{19}$

Indirect effect via Height of plant (X_2)		$= r_{42}P_{29}$
"	" via no. of tillers per plant(X_3)	$= r_{43}P_{39}$
"	" via length of spike(X_5)	$= r_{45}P_{59}$
"	" via Days to maturity (X_6)	$= r_{46}P_{69}$
"	" via no. of seed per spike(X_7)	$= r_{47}P_{79}$
"	" via 100 seed weight(X_8)	$= r_{48}P_{89}$
Total (Direct & indirect) effects		$= r_{49}$

(5) Length of spikes(X_5) and yield(X_9) :-

Direct effect		$= P_{59}$
Indirect effect via Days to flower(X_1)		$= r_{51}P_{19}$
"	" via Height of plant(X_2)	$= r_{52}P_{29}$
"	" via tillers per plant(X_3)	$= r_{53}P_{39}$
"	" No. of spikes per plant(X_4)	$= r_{54}P_{49}$
"	" Days to maturity(X_6)	$= r_{56}P_{69}$
"	" No. of seed per spike (X_7)	$= r_{57}P_{79}$
"	" 100 seed weight(X_8)	$= r_{58}P_{89}$
Total(direct & indirect) effect		$= r_{59}$

(6) Days to maturity(X_6) and yield(X_9) :-

Direct effect		$= P_{69}$
Indirect effect via Days to flower(X_1)		$= r_{61}P_{19}$
"	" via Height of plant(X_2)	$= r_{62}P_{29}$
"	" via no. of tillers per plant(X_3)	$= r_{63}P_{39}$
"	" via no. of spike (X_4)	$= r_{64}P_{49}$

Indirect effect via length of spike(X_5) $= r_{65}P_{59}$

" " via no. of seed per spike(X_7) $= r_{67}P_{79}$

" " via 100 seed weight(X_3) $= r_{68}P_{39}$

Total effects $= r_{69}$

(7) No. of seed per spike(X_7) and yield(X_9) :-

Direct effect $= P_{79}$

Indirect effect via Days to flower(X_1) $= r_{71}P_{19}$

" " via height of plant(X_2) $= r_{72}P_{29}$

" " via no. of tillers per plant(X_3) $= r_{73}P_{39}$

" " via no. of spike per plant(X_4) $= r_{74}P_{49}$

" " via length of spike(X_5) $= r_{75}P_{59}$

" " via Days to maturity(X_6) $= r_{76}P_{69}$

" " via 100 seed weight(X_8) $= r_{78}P_{89}$

Total effect(Direct + Indirect) $= r_{79}$

(8) 100 seed weight(X_8) and yield(X_9)

Direct effect $= P_{89}$

Indirect effect via Days to flower(X_1) $= r_{81}P_{19}$

" " via height of plant (X_2) $= r_{82}P_{29}$

" " via no. of tillers per spike(X_3) $= r_{83}P_{39}$

" " via no. of spike per per plant(X_4) $= r_{84}P_{49}$

" " via length of spikes(X_5) $= r_{85}P_{59}$

" " via days to maturity(X_6) $= r_{86}P_{69}$

Indirect effect via no. of seed per spike(X_7) $= r_{87}P_{79}$

Indirect effect via 100 seed weight(X_8) $= r_{89}P_{89}$

Total effect(Direct & indirect) $= r_{87}$

There values were tabulated in table no. 15 :-

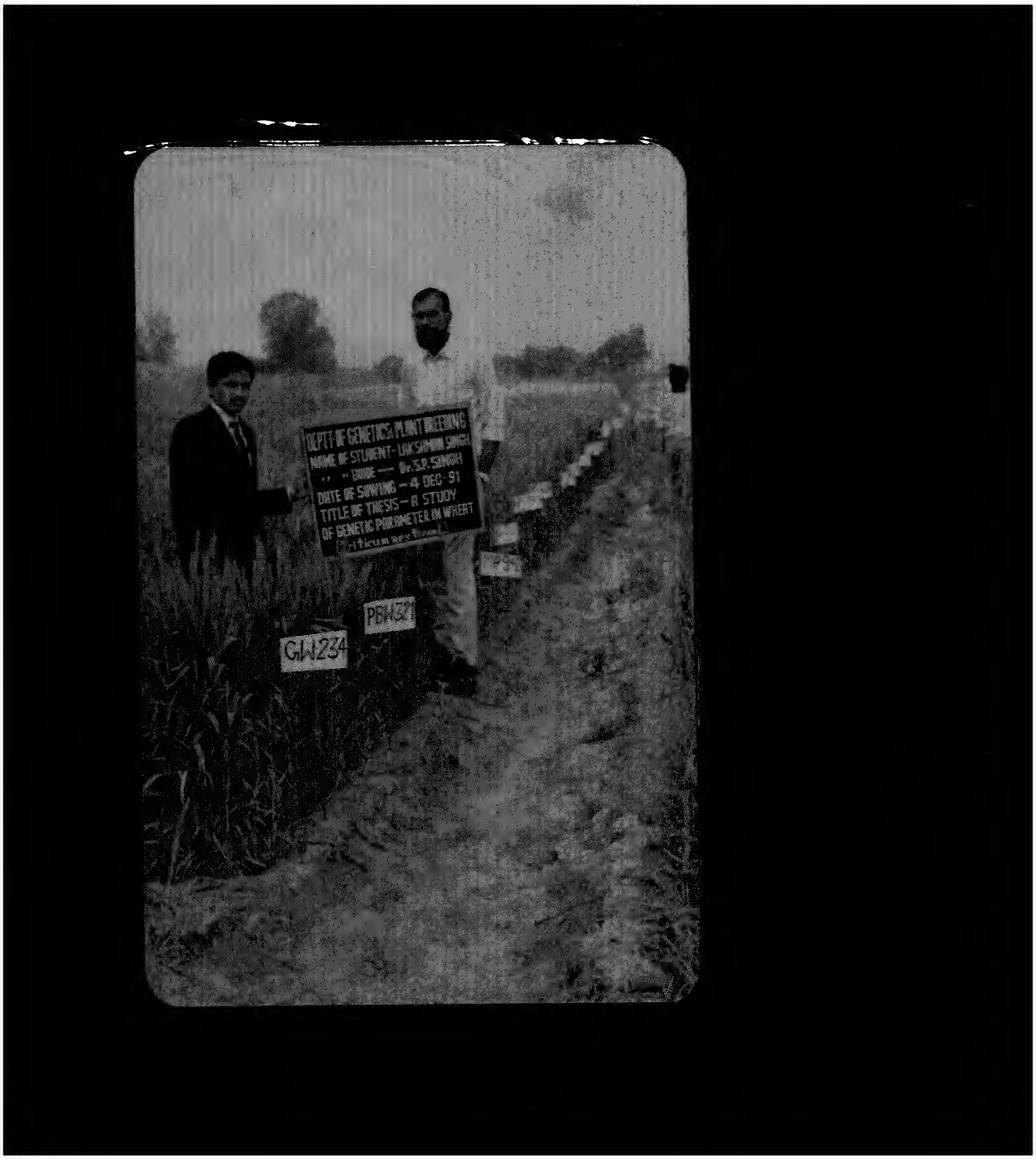
TABLE No. 15

Direct and indirect effect of different character on yield .

S.N.	Characters	Days to flower	Height of plant	No. of tillers per plant	No.of spike per plant	Length of spike	days to matu-rity	no.of seed per spikes	100 seed wei-ght	Genotypic correl-ation with yield
		1	2	3	4	5	6	7	8	
1.	Days to flower	–								
2.	Height of plant		–							
3.	No. of tillers per plant			–						
4.	No. of spikes per plant				–					
5.	Length of spikes					–				
6.	Days to maturity						–			
7.	No. of seed per spikes							–		
8.	100 seed weight								–	

(–) under line indicate direct effect and rest all is indirect effect.

CHAPTER IV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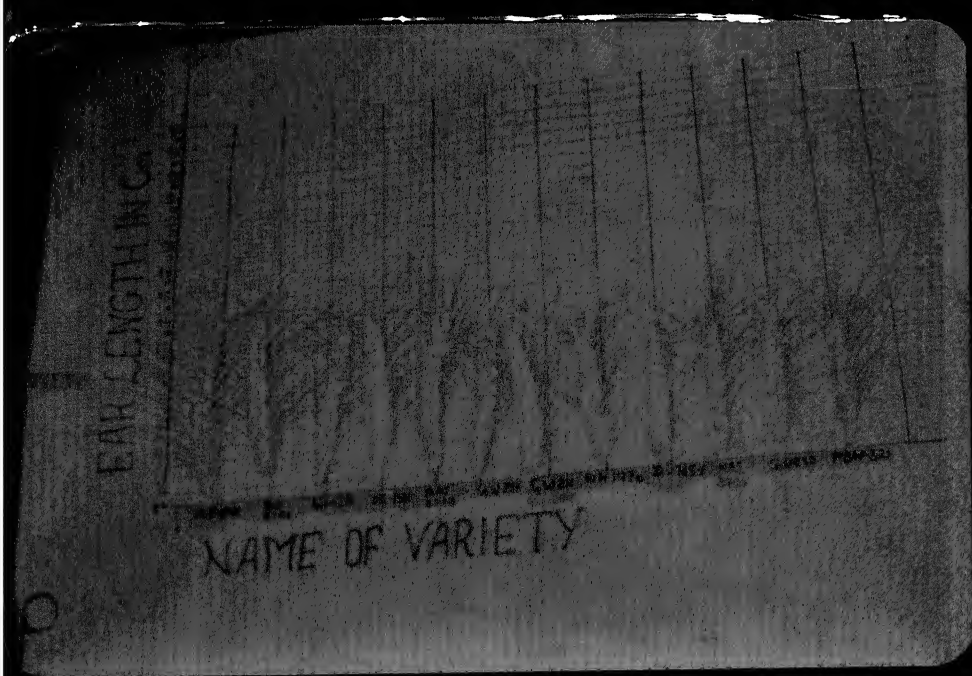
GW234


MP942


EAR LENGTH IN CM.
NAME OF VARIETY

EXPERIMENTAL FINDINGS

Yield is a complex character and there fore selection can not be made if some other phenotypically distirishable character or characters are not positively associated with the yielding ability. The present experiment had been conductes to determine those characters who are directly or indirectly related to increase th grain yield.

Experiments conducts conducted during the course of investigation include following studies.

(A) To estimate the genotypic and phenotypic variabilities.

(B) To estimate the correlation coefficient among the characters.

(C) Path analysis

(D) Heritability & genetic advance

The result obtained from these studies are presented below.

ANALYSIS OF VARIANCE :-

All the 13 varieties in the present investigation were highly and significantly variable for all the nine characters (traits). It is clear from the variability percent in the present material that the choice of lines was appropriate for the estimation of selection parameters. Mean sum of squares and

variance ratio for all 9 characters given in table 8.

TABLE NO. 8

ANOVA FOR DIFFERENT CHARACTERS.

S.N.	Characters	S.S. Repl.	S.S. Treat.	M.S.S. Repl.	M.S.S. Treat.	F ratio Treat.
1.	Days to flower	64.2307	1463.0769	21.41026	121.92308	17.787 *
2.	Height of plant(Cm)	249.8667	1471.11769	83.2889	122.5931	15.262 *
3.	No. of tiller per plant	6.65231	17.7877	2.21744	1.48231	3.87 *
4.	No. of ear per plant	14.7100	17.8800	4.90333	1.4900	4.672 *
5.	Length of spike(Cm)	8.56798	41.0789	2.85599	3.42325	9.546 *
6.	Days to maturity	22.53846	331.69231	7.51282	27.64103	11.249*
7.	No. of seed per spike	449.2136	600.989	149.73786	50.08245	4.137 *
8.	100 seed weight(gm)	.05998	6.31633	.01999	.52636	8.307 *
9.	Yield per plant(gm)	3.94049	51.62032	1.31350	4.30169	2.227 *

* Significant at 5% level

(A) Estimation of genotypic & phenotypic variabilities :-

The genotypic phenotypic and enviromental components of variance were calculated and they have been shown in the table no. 9.

TABLE NO. 9

Components of Variance :-

S.N.	Characters	$\sigma^2 g$	$\sigma^2 p$	$\sigma^2 e$
1.	Days to flower	28.76709	35.62179	6.8547
2.	Height of plant(cm)	28.64009	36.67288	8.0328
3.	No. of tiller per plant	0.27483	0.65782	0.38299
4.	No. of spike per plant	0.29278	0.61167	0.31889
6.	Length of spike(cm)	0.76616	1.12475	0.35859
6.	Days to maturity	6.29594	8.75321	2.45726
7.	No. of seed per spike	9.49438	21.59931	12.10493
8.	100 seed weight(gm)	0.11575	0.17912	.06337
9.	Yield per plant (gm)	0.59253	2.52409	1.93156

The genotypic variance of days to flower(28.76709) Height of plant(28.64009) and Number of seed per spike(9.49438) were found high. The phenotypic variance of Days to flower (35.62179), height of plant(36.67288) and number of seed per spike(21.59931) were found high, where as the other characters

showed considerable variance. The high variance of the respective charaeters indicate about the deminant genes related for the same. The low variances indicate about the relation of the respective character with the recessive genes. With the help of genotypic and phenotypic components variance the respective coeffecient of variation and phenotypic components of variance of the respective coefficient of variation had been calculated and they have been presented in table no. 10.

TABLE NO. 10

Genotypic & phenotypic coefficient of variability.

S.N.	Characters	Genotypic variability	Phenotypic variability
1.	Days to flower	6.94823	7.73186
2.	Height of plant(Cm)	5.58683	6.32194
3.	No.of tiller per plant	7.50566	11.61211
4.	No. of spike per plant	8.65743	12.51346
5.	Length of spike(Cms)	9.11561	11.04467
6.	Days to maturity	2.03298	2.39711
7.	No. of seed per spike	6.50339	9.80904
8.	100 seed weight(gms)	8.48669	10.55717
9.	Yield per plant(gms)	6.56363	13.5469

The genotypic variability of all characters were found considerable on the other hand the phenotypic variabilities were found satisfactory expect days to maturity. On the whole the variability indicates that the selection breeding programme with

the help of these caracters can be adopted.

(B) Estimation of correlation coefficient :-

Components of co- variance were calculated for the different combinations of charaters before the calculation of correlation coefficients. The genotypic, phenotypic and environmental covariance were calculated and they been shown in table no. 11.

TABLE NO. 11

S.N.	Characters	$6^2 g_1 g_2$	$6^2 p_1 p_2$	$6^2 e_1 e_2$
1.	Days to flower VS Height of Plant(cm)	-1.02361	-0.81074	0.21287
2.	" " VS No.of tiller per plant	0.14754	0.16603	0.01848
3.	" "VS No.of spike per plant	0.36207	0.50128	.13921
4.	" " VS Length of spike(cm)	0.75118	1.08934	.33817
5.	" " VS Days to maturity	10.72329	9.95673	-.76656
6.	" " VS No.of seed per spike	3.06903	4.84139	1.77236
7.	" " VS 100 seed seight(gm)	-0.73398	-.73710	-.00312
8.	" " VS Yield per plant(gm)	-1.13520	-.63247	.50274
9.	Height of plant(cm) VS No. of tillers per plant	0.09304	0.029981	-.06324

S.N.	Characters	$6^2g_1g_2$	$6^2p_1p_2$	$6^2e_1e_2$
9.~~10~~.	Height of plant(cm)VS no. of tillers per plant	0.09304	0.02981	-.06324
10.	" " VS No. of spike per plant	.18500	-.40708	-.22208
11.	" " VS Length of spike	2.76705	3.16574	0.39817
12.	" " VS Days to maturity	-3.76175	-4.98045	-1.21870
13.	" " VS No.of seed per spike	3.87133	2.31417	-1.55716
14.	" " VS 100 seed weight	0.23314	0.33772	0.10458
15.	" " VS Yield per plant	0.44015	0.10942	-.33073
16.	No.of tillers per plants VS No. of spike per plant	0.28387	0.58590	0.30203
17.	" " VS Length of spike	0.04467	0.15632	0.11166
18.	" " VS Length of spike	0.10107	-0.20000	-.30107
19.	" " VS no.of seed per spike	-.14165	-.26484	-.12319
20.	" " VS 100 seed weight	0.07280	0.07853	.00574
21.	" " VS Yield per plant	0.37467	0.67233	.29765
22.	No. of spike per plant VS Length of ear(Cm)	0.7346	0.14749	.07403
23.	" " VS Days to maturity	0.12158	-.16474	-.28632
24.	" " VS No.of seed / spike	-0.00348	.28818	.25166
25.	" " VS 100 seed weight	0.03952	.03112	-.00840

S.N.	Characters	$6^2g_1g_2$	$6^2p_1p_2$	$6^2e_1e_2$
26.	No. of spike per plant VS Yield per plant	0.34861	.62709	0.27848
27.	Length of spike VS Days to maturity	-0.04080	-.23226	-.19146
28	" " VS No.of seed per spike	2.20058	2.36543	.16485
29.	" " VS 100 seed weight	-.00998	.00584	.01582
30.	" " VS Yield per plant	0.10795	.24272	.13477
31.	Days to maturity VS no.of seed per spike	1.84324	1.09481	-.74843
32.	" " VS 100 seed weight	-17407	-.26317	-.08910
33.	" " VS Yield per plant	-.26355	-.48013	-.21658
34.	No.of seed per spike 100 seed weight VS Yield per plant	-.79130	-.48773	0.30357
35.	" " VS Yield per plant	-1.41036	1.01710	2.42746
36.	100 seed weight VS Yield per plant(in Gms)	0.20400	0.32023	0.11623

Out of thirty six, twenty three genotypic and twenty four phenotypic covariances were found positive. Some of them were high which indicated the better association with the respective combination of characters.

Simple correlation(genotypic correlation) of different pair of characters had been calculated and they have been presented in table no. 12

TABLE NO. 12

Genotypic correlations between different characters.

S.N.	Characters	Simple co-rrelation
1.	Days to flowering VS Height of plant	-0.03566
2.	" " "VS no.of tiller / plant	0.05247
3.	" " " VS no.of spike / plant	0.12476
4.	" " " VS Length of spike	0.16000
5.	" " " VS Days to maturity	0.79680 *
6.	" " " VS no.of seed / spike	0.18570
7.	" " " VS 100 seed weight	-.40223 *
8.	" " " VS Yield per plant	-.27496
9.	Height of plants VS no. of tiller / plant	0.03316
10.	" " " VS no.of spike / plant	-.06389
11.	" " " VS Length of spike	0.59070 *
12.	" " " VS Days to maturity	-.28014
13.	" " " VS no.of seed / spike	0.23477
14.	" " " VS 100 seed weight	0.12805
15.	" " " VS Yield / plant	0.10685
16.	No. of tiller / plant VS no.of spike/plant	0.99973 *

S.N.	Characters	Simple Co- rrelation
17.	No. of tillers/plant VS Length of spike	0.09734
18.	" " " VS Days to maturity	0.07683
19.	" " " VS No.of seed/spike	-.08769
20.	" " " VS 100 seed weight	0.40815*
21.	" " " VS Yield / plant	0.92846 *
22.	No.of spike/plant VS Length of spike	0.15510
23.	" " " VS Days to maturity	0.08955
24.	" " " VS No.of seed / spike	-.00209
25.	" " " VS 100 seed weight	0.21466
26.	" " " VS Yield / plant	0.83698 *
27.	Length of spike VS Days to maturity	-.01857
28.	" " " VS no.of seed / spike	0.81591 *
29.	" " " VS 100 seed weight	-.03351
30.	% " " VS Yield / plant	0.16021
31.	Days to maturity VS no.of seed / spike	0.23841
32.	" " " VS 100 seed weight	-.20391
33.	" " " VS Yield / plant	-.13645
34.	No.of Seed/spike VS 100 seed weight	-.75483 *
35.	" " " VS Yield per plant	-.59462 *
36.	100 seed weight VS Yield per plant	0.77895 *

* Significant at 5% level .

(a) Association of different characters with yield per plant :-

(I) Days to flowering VS Yield per plant :-

The genotypic correlation(-0.27496) was negative and non significant between these two characters indicated there was no relationship between them.

(II) Height of plant VS Yield per plant :-

A positive but non significant genotypic correlation (0.10685) was found between these two character which indicated that there is no relationship between height of plant & yield per plant.

(III) No. of tillers per plant VS Yield per plant :-

A positive & significant correlation coefficient (0.92846) indicated that there was a strong relationship between no. of tillers per plant and yield per plant.

(IV) No. of spikes per plant VS Yield per plant :-

The genotypic correlation(0.83698) was found positive & significantly which indicated there was a strongly relationship between no. of spikes per plant and yield per plant.

(V) Length of spikes VS Yield per plant :-

A positive & non-significant correlation(0.16021) was found between these two characters which indicated there was no relationship between length of spike and yield.

(VI) Days to maturity VS Yield per plant :-

A negative & non significant correlation (-0.13645) was found between these two character which indicated that there is no relationship between days to maturity & yield per plant.

(VII) No. of seed per spikes VS Yield per plant :-

The genotypic correlation(-0.59462) was found negative but significant between these two characters which indicated there was negative relationship between no. of seed per spike and yield per plant.

(VIII) 100 Seed weight VS Yield per plant :-

A positive and significant correlation was found(0.77895) between these two characters which indicated that there was strong relationship between 100 seed weight and yield.

(B) Association of different characters other then yield :-

(I) Positive and significant correlation among the characters:-

Following combination of characters, were found positive and significant, days to flowering VS.days to maturity (0.7968), height of plant VS length of spike(0.5907), no. of tillers per plant Vs. test weight(0.40815), no. of tillers per plant Vs.no. of spikes per plant(0.99973), and length of spikes Vs no. of seed per spikes(0.81591).

(II) **Negative and significant correlation among the Characters:**

Days to flowering Vs. test weight(-0.40223) and no. of seed per spikes Vs. 100 seed weight(-0.75483) were found negatively but significnatly correlation among themselvs.

(III) **Positive but non significant correlations among the characters :-**

Days to flowering Vs no. of tillers per plant(0.05247) days to flowering Vs no. of spikes per plant(0.1600), days to flowering Vs no. of seed per spikes(0.1857), height of plant Vs no. of tillers per plant(0.03316), height of plant Vs 100 seed weight(0.12805), height of plant Vs no.of seed per spikes(0.23477), nO.of tillers per plant Vs length of spikes(0.09734), no.of tiller per plant Vs days to maturity(0.07683), no. of spikes per plant Vs length of spike(0.1551), no. of spikes per plant Vs days to maturity(0.08955), no. of spikes per plant Vs 100 seed weight (0.21466) & days to maturity Vs no. of seed per spike(0.2384) were found positive and non significant correlation among the characters.

(IV) **Negative but non significant correlation among the characters :-**

Days to flowering Vs height of plant(-0.03566), height of plant Vs no.of spikes per plant(-0.06389), height of

plant Vs days to maturity(-0.28014), no.of tillers per plant Vs no. of seed per spikes(-0.08769), No. of spikes per Vs no. of seed per spikes(-0.00299), length of spikes Vs days to maturity(-0.01857), length of spikes vs 100 seed weight(-0.03351) and days to maturity(-0.20391) were found negatively and non significantly correlated among themselves.

The genotypic and phenotypic correlation coefficients for nine character in wheat also have been shown in table no. 13.

TABLE NO. 13

Genotypic and phenotypic correlation coefficient for nine characters in wheat.

S.N. Characters		Days to flowers	Height of Plant (in cms.)	No. of tiller/ plant	No. of spikes/ plant	Length of spike (in cms)	Days to maturi-ty	No.of seed/ spike	100 seed weight (in gms)	Yield per plant (in gms)
1. Days to flower	G		-.03566	0.05244	0.12476	0.1600	0.7968 *	0.1857	-.40223 *	-.27496
	P		-.02243	0.03430	0.10739	0.1721	0.5638 *	-.1745	-.29180	-.06670
2. Height of plant	G			0.03316	-.06389	0.5907 *	-.28014	0.2347	0.12805	0.10685
	P			0.00607	-.08595	0.4929 *	-.27798	0.0822	0.13177	0.01137
3. No.of tillers per plant	G				0.99973 *	0.0973	0.07683	-.0876	0.40815 *	0.92846 *
	P				0.92366 *	0.1817	-.08335	-.0702	0.22878	0.52176 *
4. No. of spike per plant	G					0.1551	0.08955	-.0020	0.21466	0.83698 *
	P					0.1178	-.07120	0.06828	.09401	0.50468 *
5. Length of spike(in(Cms)	G						-.01857	0.8159 *	-.03351	0.16021
	P						-.07402	0.479 *	0.01301	0.14405
6. Days to Maturity	G							0.23841	-.20391	-. 13645
	P							0.07962	-.21018	-.102150
7. No.of seed per spike	G								-.75483 *	-.59462 *
	P								-.24797	0.13775
8. 100 seed weight(in Gm)	G									0.77895 *
	P									0.47626 *
9. Yield per plant(Gms)	G									
	P									

* Significant at 5% level

(c) Path analysis(Direct and indirect effect of different characters on yield :-

Before adopting the selectiion breeding programme the breeder has to work out the effects of the particular character on yield. Through the correletion coefficient, we reached on the conclusion that the no. of tillers per plant, no. of spike per plant and 100 seed weight are positively and significantly associated with yield. no. of seed per spike was found negative and significantly correlated with yield. The height of plant and length of spike were positively and non significantly correlated with yield. Days to flower and days to maturity were negative and non-significantly with yield. But it is not clear that whether these characters have the direct and indirect effects on yield.

To detect the same the direct and indirect effect of these characters on yield have been calculated and they have been presented in table no. 14.

TABLE NO. 14

Direct and indirect effect on yield(Path values).

S. N.	Characters	Days to flowers	Height of plant (in cms)	No.of tiller/ per plant	No. of spikes/ plant	Length of spike (im cms)	Days to maturi-ty	No. of seed/ spike	100 seed weight. (im gms)	Geno. Corr. with yield
1.	Days to flowers	0.64023	0.00922	0.07406	-0.09608	-0.05155	-0.57173	0.1217	-0.40082	-.27496
2.	Height of plant	-0.02283	-0.25850	0.0468	0.0492	-0.19033	0.2010	0.1538	0.1276	0.10685
3.	No.of tillers per plant	0.0335	-0.0085	1.4113	-0.7707	-0.03136	-0.0551	-0.0574	0.4067	0.92846 *
4.	No. of spike per plant	0.0798	0.0165	1.4124	-0.7714	-0.04998	-0.06426	-0.0013	0.2139	0.83698 *
5.	Length of spike	0.1024	-0.1526	0.1373	-0.1194	-0.3222	0.133	0.5348	-0.0339	0.16021
6.	Days to maturity	0.5101	0.0724	0.1084	-0.0689	0.0059	-0.7175	0.1562	-0.2031	-0.1364
7.	No.of seed per spike	0.1188	-0.0606	-0.1237	0.0016	-0.2628	-0.1710	0.6554	-0.7521	-0.59462 *
8.	100 seed weight	-0.2575	-0.0321	0.5760	-0.1653	0.0108	0.1463	-0.4947	0.9964	0.77895 *

(____) Under line values indicated direct effect of the respective character on yield.

* Significant at 5% level

Residual effect = 0.10507571

(a) Days to flowerings and yield :-

Direct effects	= 0.64023
Indirect effect via Height of plant	= 0.00922
Indirect effect via no. of tillers per plant	= 0.07406
Indirect effect via no. of spikes per plant	= -0.09603
Indirect effect via length of spikes	= -0.05155
Indirect effect via Days to maturity	= -0.57173
Indirect effect via no. of seeds per spikes	= 0.12172
Indirect effect via 100 seed weight	= -0.40082
Total(Direct & Indirect) effect	= -0.27496

(b) Height of plant and yield :-

Direct effect	= -0.25850
Indirect effect via Days to flowering	=-0.82283
Indirect effect via No. of tiller per plant	= 0.04681
" " via no. of spikes per plant	= 0.04920
" " via Length of spikes	=-0.19033
" " via Days to maturity	= 0.20101
" " via no. of seed per spikes	= 0.15388
" " via 100 seed weight	= 0.12760
Total (Direct & Indirect) effects	= 0.10685

(c) No. of tillers per plant and yield :-

Direct effect		= 1.41139
Indirect effect via Days to flowering		= 0.03359
" "	via Height of plant	= -0.00857
" "	via no. of spikes per plant	= -0.77070
" "	via length of spikes	= -0.01136
" "	via Days to maturity	= -0.05513
" "	via no. of seed per spikes	= -0.05748
" "	via 100 seed weight	= 0.40672
	Total(Direct & Indirect) effect	= 0.92846**

(d) No. of spikes per plant and yield :-

Direct effect		= -0.77014
Indirect effect via Days to flowering		= 0.07988
" "	via Height of plant	= 0.01651
" "	via no. of tillers per plant	= 1.41242
" "	via Length of spikes	= -0.04998
" "	via Days to maturity	= -0.06428
" "	via no. of seed per spikes	= -0.00137
" "	100 seed weight	=0.21390
	Total(Direct & Indirect)effects	= 0.83698**

(e) Length of spikes and yield :-

Direct effect		= -0.32221
Indirect effect via Days to flowers		= 0.10244
" "	via Height of plant	= -015269
" "	via no. of tiller per plant	= 0.13738
" "	via no. of spikes per plant	= -0.11945
" "	via Days to maturity	= 0.01333
" "	via no. of seeds per spikes	= 0.53481
" "	via 100 seed weight	= -0.03339
	Total(Direct & Indirect) effects	= 0.16021

(f) Days to maturity and yield :-

Direct effect		= -0.71754
Indirect effect via Days to flowering		= 0.51014
" "	via Height of plant	= 0.07241
" "	via no. of tillers per plant	= 0.10844
" "	via no. of spikes per plant	= -0.06897
" "	via length of spikes	= 0.00598
" "	via no. of seed per spike	= 0.15627
" "	via 100 seed weight	= -0.20319
	Total(Direct & Indirect) effects	= -0.13645

(g) No. of seed per spikes and yield :-

Direct effect			= 0.65547
Indirect effects via Days to flowers			= 0.11889
"	"	via Height of plant	= -0.06069
"	"	via no. of tiller per plant	= -0.12377
"	"	via no. of spikes per plant	= 0.00161
"	"	via length of spikes	= -0.26289
"	"	via Days to maturity	= -0.17107
"	"	via 100 seed weight	= -0.75217
		Total (Indirect & Direct) effects	= -0.59462**

(h) 100 seed weight on yield :-

Direct effect			= 0.99648
Indirect effect via Days to flowers			= -0.25752
"	"	via Height of plant	=-0.03310
"	"	via no. of tiller per plant	= 0. 57609
"	"	via no. of seed per spikes	= -0.16532
"	"	via length of spikes	= 0.01080
"	"	via Days to maturity	= 0.14631
"	"	No. of seed per spikes	= -0.49477
		Total Direct & Indirect effects	= 0.77895 *

* Indicates Genotypic correlation with yield & Significant at 5% level

The direct effect of no, fo tillers per plant(1.4139), and 100 seed weight (0.99648) were found high which may be cause of positive and significant correlation value between this character and yield.

The direct effect of Height of plant(-0.2585) and no. of spike per plant(-0.77014), Length of spikes(-0.32221), Days to maturity(-0.71754) were found negative.

The direct effect of days to flower(0.64023) & no. of of seed per spikes(0.65547) were found positive & their correlation value were negative.

The residual effect indicated that these eight characters days to flower, Height of plant, no. of tiller per plant, no. of spikes per plant, Length of spikes , Days to maturity, no. of seed per spike and 100 seed weight have 90% effects on yield.

(D) HERITABILITY & GENETIC ADVANCE :-

To found out the mode of genes of character whether they are heritable or not. The heritability in percentage and genetic advance had been calculated which have been given in table no.15.

Among the Nine characters Days to flower(80.757), Height of plant(78.096), Length of spike (68.1185), Days to maturity(71.92725) and test weight(64.622) showed high heritability (above 50%) and no. of tiller per plant(47.86558), no.of seed

per spike(43.956) & Yield(23.475) showed medium percentage of heritability. The genetic advance of each character were found low.

The high and medium heritability and low genetic advance promised that the selection through these character will prove use full for the further breeding programme.

TABLE NO. 15.

Heritability and Genetic advance (in %)

S.N.	Characters	Heritability (%)	Genetic Advance
1.	Days to flower	80.7570	9.92900
2.	Height of plant(Cm)	78.09608	9.74247
3.	No. of tillers per plant	41.77873	0.69803
4.	No. of spike per plant	47.86558	0.77117
5.	Length of spike(Cm)	68.11851	1.48820
6.	Days to maturity	71.92725	4.38373
7.	No. of seed per spike	43.95686	4.20837
8.	100 seed weight(gms)	64.62214	0.56340
9.	Yield per plant(gms)	23.47512	0.76829

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Genotypic Coefficient of Variability

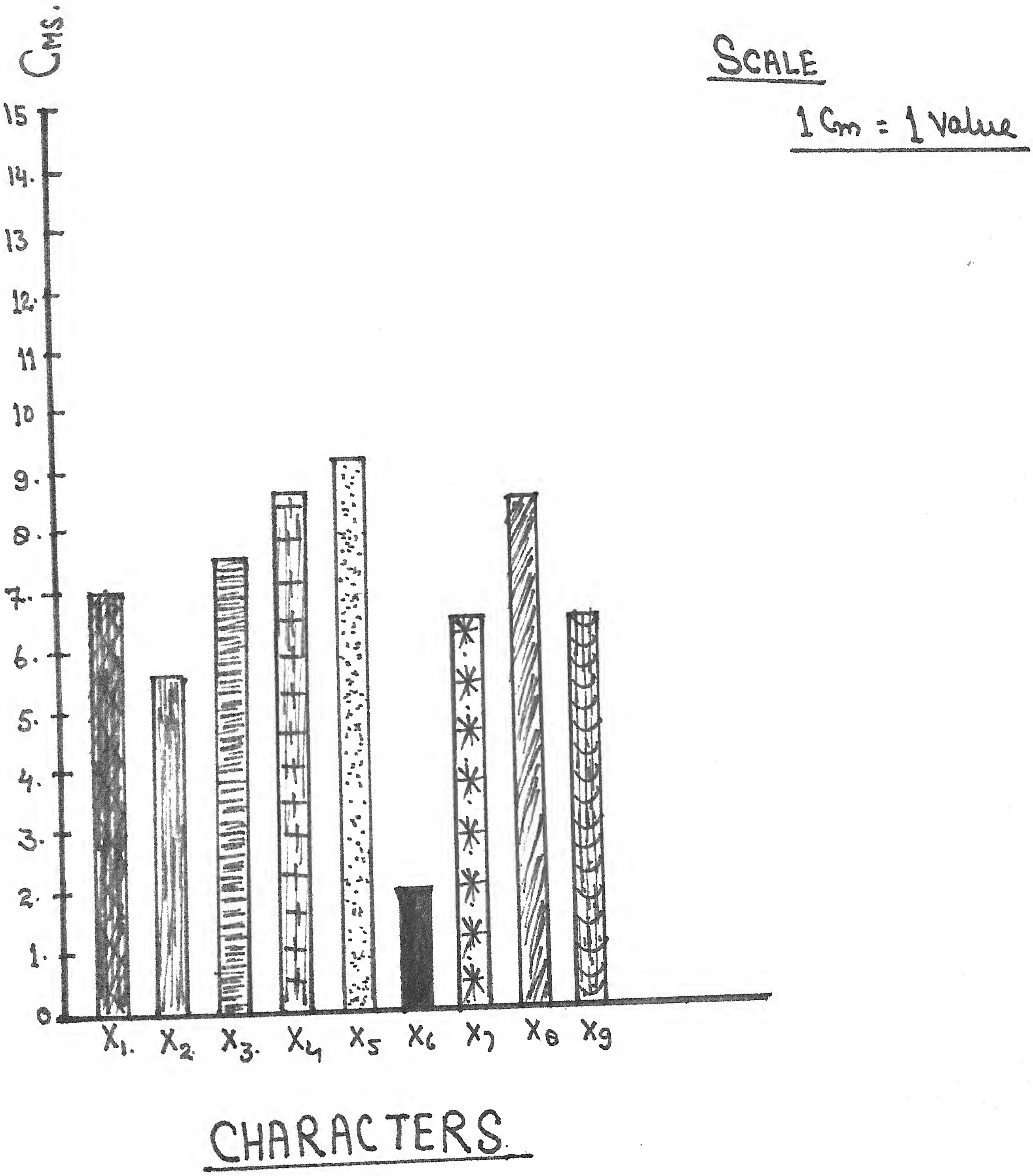


Fig. No. 1.

Phenotypic Coefficient of Variability.

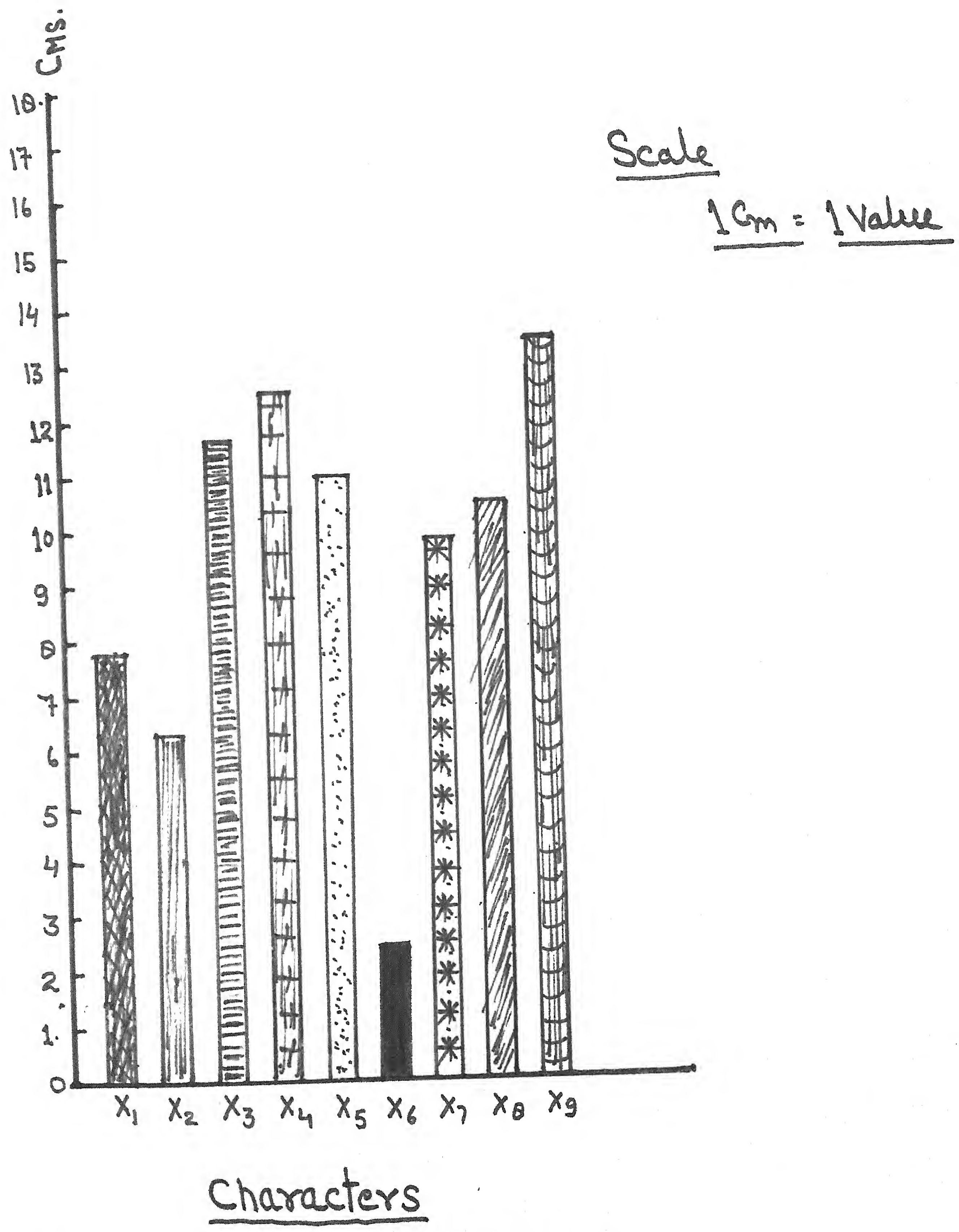


Fig. No. 2.

HERITABILITY %

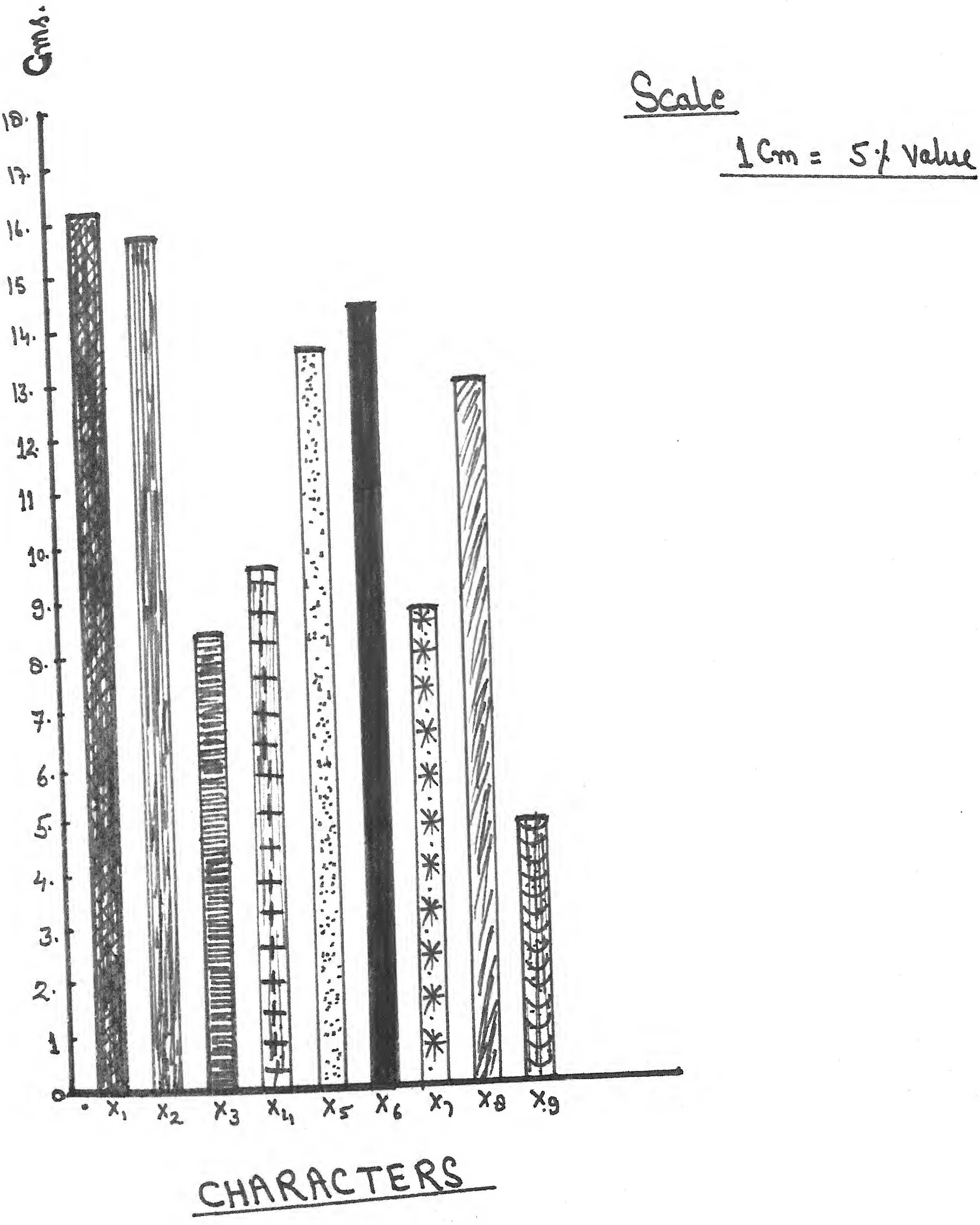
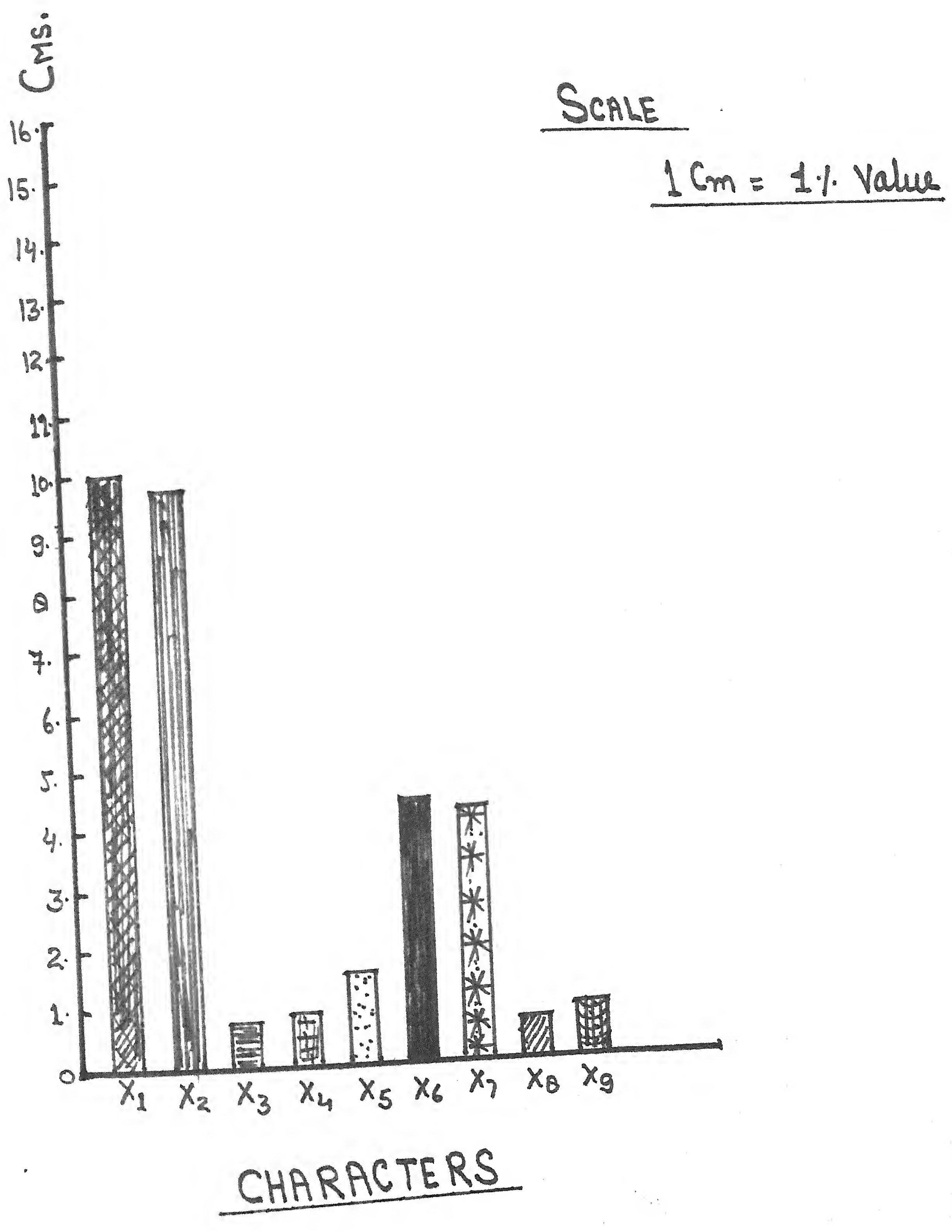


Fig-No.3

GENETIC ADVANCE %



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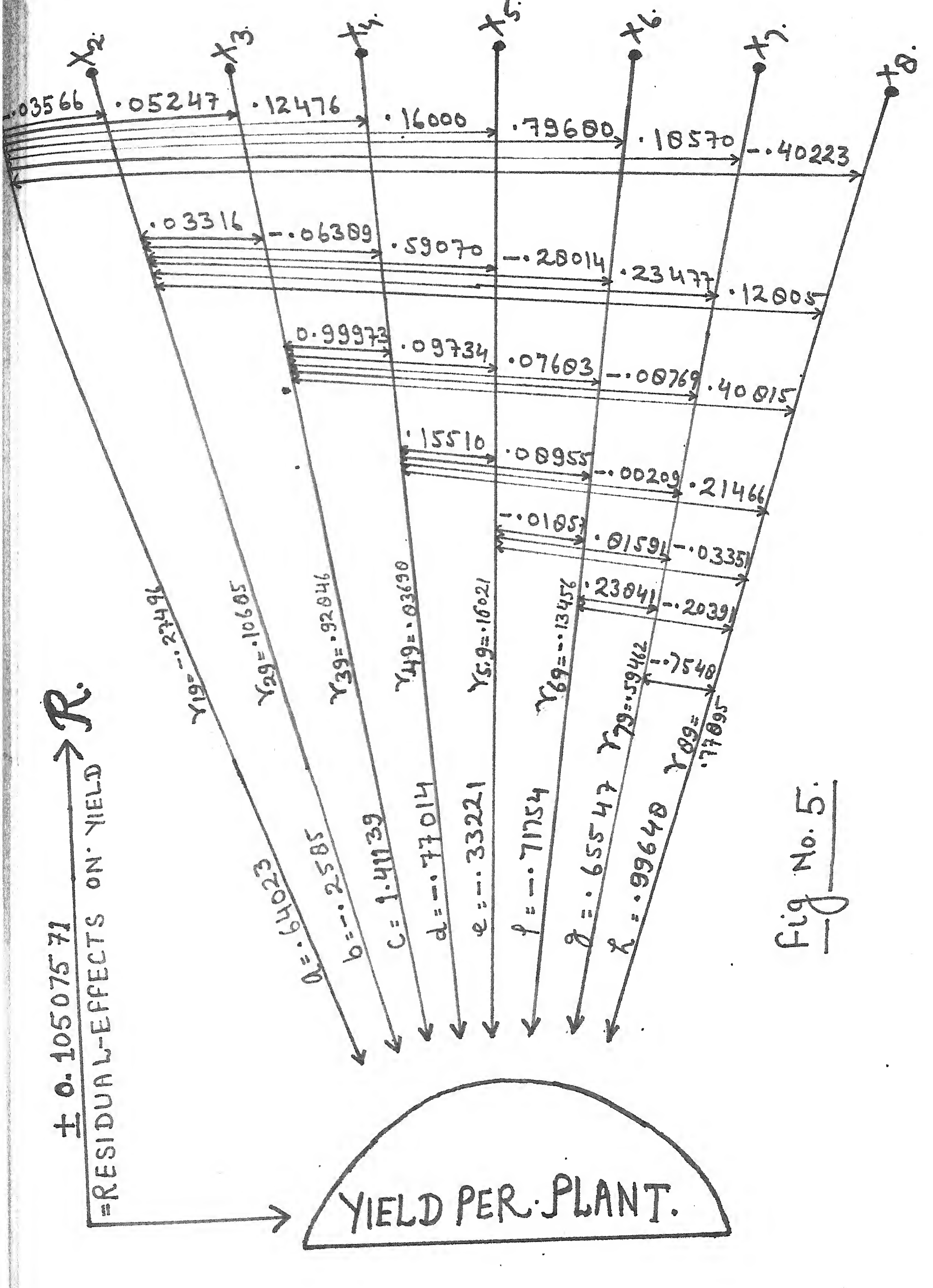

SHOWING CAUSE AND EFFECT RELATIONSHIP.

Fig. No. 5

PATH DIAGRAM.

CHAPTER V

DISCUSSION

The main objectiveof any plant breeder is to evolve the new varieties the existing varieties. The present experiment an endeavour has been adopted to select a better plant with the help of selection methodalogy. Yield is a complex character in crop because it is related with so many characters. But there are some characters who specially affect the yield. We call them yield contributing characters or yield components.

We have some statistical and biometrical methods to detect those characters upon which the selection can be made.

The genotypic and phenotypic variabilities of all the characters except days to maturity were found high. The variabilities, on the whole were satisfactoryand on the basis of this, it can be said that the selection can be made easily through these characters.

CORRELATION STUDY :-

In the present investigation,only four characters namely no. of tillers per plant, no. of spike per plant, no. of seed per spike and 100 se d weight showed their true relationship with the grain yield because of having significant correlations with yield.

Among the above four characters, no. of tillers, no. of spikes and 100 seed weight exhibited positive correlation whereas no. of spike per plant showed negative correlation with yield. This indicated that more tillers per plant, more spikes per plant and bold seeds increase the yield whereas less seed per spike indicates about the possession of bold seeds.

The similar findings have also been repotted by the following authors.

According to Arvy and Garber(1918), Dunder(1974), Sidewell et.al.(1976), Dimitriew et.al.(1980), Singh and Awashthi (1984), Sandhu et.al.(1985), Kumar and Chaudhary (1986), Nachit and Jarah(1986), Singh et.al.(1987) and Krotova(1988) no. of tillers per plant was found positively and significantly correlated with yield.

Jaimini et.al.(1974) reported positive and significant correlation of yield with no. of spike per plant and 100 seed weight.

Jain and Singh(1975). revealed positive and significant correlation between 1000 seed weight and yield.

Barriga(1974) found positive correlation of yield with spikes per plant

Virh and Singh(1972) found positive correlation of yield with of no. of spike per plant and 1000 seed weight.

PATH ANALYSIS STUDY :-

Through path analysis we determine the direct and indirect effects of the characters on yield. In the present investigation only four characters namely no. tillers per plant, no. of spikes per plant, no. of seed per spike and 100 seed weight have shown their significant correlation with yield. So, we have to see wheather these characters effect the yield directly or indirectly.

The highest and positive direct effect on yield was shown by no. of tillers per plant, followed by 100 seed weight. So these two characters affect the yield directly. On the other hand number of spikes per plant and number of seed per spike showed poor direct effect which indicated that these two characters affect the yield indirectly.

On the basis of path analysis it can be said that no. of tillers had the strongest influence on yield.

Jatarsa and Paroda(1985) and Jadav and Jadav(1987) also found greatest direct effect of tillers per plant on yield.

HERITABILITY AND GENETIC ADVANCE :-

Most of the characters exhibited high heritability

Whereas no. of tillers per plant, no. of spike per plant, no. of seed per spike, and yield per plant showed medium heritability. Heritabilities, on the whole, were considerable. On the other hand the genetic advance of all the characters were found low. The high or medium heritability and low genetic advance promised that the selection through these characters will prove useful for the further breeding programme.

It is, therefore, suggested that the selection methodology can be adopted to improve the yielding ability in wheat. At the time of selection the priority should be should be given to more no. of tillers per plant. For the better result more tillered, more spiked, more sheeded spike and bold seeded plant should be selected.

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CHAPTER VI

SUMMARY

The present investigation" A Study Of Genetic Parameter In Wheat, (*Triticum aestivum*.L..*em*.*Thell*)", had been started during the rabi season of 1991-92. The seed of 13 varieties of wheat obtained from the department of genetics and plant breeding C.S.A. University of Agriculture and Techonology, Kanpur. The material was sown on the farm of Brahmanand Post Graduate College, Rath (Hamirpur) in randomized block design with four replications. It was sown in December 4, 1991.

Thirteen varieties of wheat namely G W-234, PBW - 321, MP-942, GW- 232, WH - 147(c), DL- 765-1, Raj- 3783, HD- 2630, GW- 230, Raj- 3785, Raj- 3786, HI- 1383 and GW- 231, wer sown for the investigation. The data Viz. Days to flowers, Height of plant, number of tillers per plant, number of spikes per plant, length of spike, days to maturity, No. of seed per spike, 100 seed weight and yield per plant had been recorded. proper statistical methods had been adopted for the following calculations.

(a) To estimate of genotypic and phenotypic variabilities.

(b) To estimate co-rrelation coefficients.

(c) To estimate path coefficients.

(d) To estimates heritability and genetic advance.

The genotypic and phenotypic variabilities of all characters except days to maturity were found high. On the basis of variability the selection can be made.

The genotypic correlation values reveled that out of eight only four characters namely,number of tiller per plant, number of seed per spike, no. of spikes per plant and 100 seed weight showed their significant correlations with yield which indicated that these four characters had the true relationship with yield . It is to be noted that no. of tillers, no. of spike and 100 seed weight showed positive and significant correlations whereas number of seed per spike exhibited negative and significant correlations with yield.

We had considered all the eight characters for path analysis to determine the direct and indirect effects of all the characters on yield. Though we found only four characters which had their true relationship with yield so it was better to concentrate our mind on only the four characters. According to path analysis the highest and positive direct effect on yield was exhibited by no. of tillers per plant, followed by 100 seed weight. The direct effects of no. of spikes per plant and no. of seeds per spike were found negative and positive respectively.

which were irrelavant to their correlation values. This indicated that these to characters were affecting the yield indirectly. Only whole number of tiller per plant had the strongest influence on yield .

The residual effect indicated that 90% yield was being contributed by the eight characters.

Through heritability percentages it come to know that out of nine, five characters showed high heritability and those were days to flower, plant hight, length of spike, days to maturity and 100 seed weight. The rest four characters namely no. of tillers per plant, number of spike per plant, number of seed per spike and yield per plant showed medium heritability. On the other hand all the characters showed low genetic advance. The high or medium heritability and low genetic advance indicated that the selection through these characters will be useful for the further breeding programme.

It was, therefore, suggested that the selection methodology could be adopted for the development in yielding ability of wheat crop. During the selection period the emphasis should be given to more no. of tillers per plant. For the better result the plants with more number of spikes and bold seeds must be considered.

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CHAPTER VII

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CHAPTER VIII

APPENDICES

THE TABLE OF ANALYSIS OF VARIANCE :

TABLE - 1

ANOVA FOR DAYS TO FLOWERING(X_1)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	64.23077	21.41026	3.123
2.	Treatment	12	1463.07692	121.92308	17.787**
3.	Error	36	246.76923	34.78582	
Total		51	1774.07692		

TABLE NO - 2

ANOVA FOR HEIGHT OF PLANT(in Cms.) (X_2)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	249.866	83.2889	10.369
2.	Treatment	12	1471.11769	122.5931	15.262*
3.	Error	36	289.1807	8.0328	
Total		51	2010.1652		

TABLE NO 3

ANOVA FOR NO. OF TILLERS PER PLANT (X_3)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	6.65231	2.21744	5.79
2.	Treatment	12	17.78769	1.48231	3.87 *
3.	Error	36	13.78769	0.38299	
Total		51	38.22769		

TABLE NO 4

ANOVA FOR NO. OF SPIKE/ PLANT (X_4)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	14.71	4.903	15.376
2.	Treatment	12	17.88	1.490	4.672 *
3.	Error	36	11.48	0.31889	
Total		51	44.07		

TABLE NO 5

ANOVA FOR LENGTH OF SPIKE(in Cms) (x_5)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	8.56798	2.856	7.965
2.	Treatment	12	41.07897	3.423	9.546 *
3.	Error	36	12.90917	0.3586	
Total		51	62.556		

TABLE NO. 6

ANOVA FOR DAYS TO MATURITY (X_6)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	22.5384	7.5128	3.057
2.	Treatment	12	331.6923	27.6411	11.249 *
3.	Error	36	88.4615	2.4572	
Total		51	442.6923		

TABLE NO. 7

ANOVA FOR NO. OF SEED PER SPIKE (X_7)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	449.21358	149.73786	12.370
2.	Treatment	12	600.98937	50.08245	4.137 *
3.	Error	36	435.7780	12.10488	
Total		51	1485.9805		

TABLE NO. 8

ANOVA FOR 100 SEED WEIGHT (In Gms.) (X_8)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	0.05998	0.01999	0.315
2.	Treatment	12	6.31633	0.52636	8.307 *
3.	Error	36	2.28122	0.06337	
Total		51	8.65753		

TABLE NO. 9

ANOVA FOR YIELD PER PLANT (In Gms.) (X_9)

S.N.	Source	d.f.	S.S.	M.S.S.	F ratio
1.	Replication	3	3.94049	1.31350	0.680
2.	Treatment	12	51.62032	4.30169	2.227 *
3.	Error	36	69.53611	1.93156	
Total		51	125.09692		

* Significant at 5% level

TABLE NO. 10

ANCOV FOR DAYS TO FLOWER Vs HEIGHT OF PLANT(In Gms.) (x_1x_2)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-47.988	-15.99615	75.145
2.	Treatment	12	-46.578	-3.88157	18.234
3.	Error	36	7.663	0.21287	
Total		51	-86.9038		

TABLE NO. 11

ANCOV FOR DAYS TO FLOWER VS NO. OF TILLERS/PLANT(X_1X_3)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-5.01538	-1.67179	90.4648
2.	Treatment	12	7.30385	0.60865	32.9356
3.	Error	36	0.66538	0.01848	
Total		51	2.95385		

TABLE NO. 12

ANCOV FOR DAYS TO FLOWERS VS. NO. OF SPIKE/PLANT(X_1X_4)

S.N.	Source	d.f.	S.P.	M.S.P.	F.
1.	Replication	3	-16.36154	-5.45385	39.177
2.	Treatment	12	19.0500	1.58750	11.4036
3.	Error	36	5.01154	0.13921	
Total		51	7.7000		

TABLE NO. 13

ANCOV FOR DAYS TO FLOWER VS LENGTH OF SPIKE(in cms.) (X_1X_5)

S.N.	Source	d.f.	S.P.	M.S.P.	F ratio
1.	Replication	3	-3.68154	-1.22718	3.6288
2.	Treatment	12	40.11442	3.34287	9.8851
3.	Error	36	12.17404	0.33817	
Total		51	48.60692		

TABLE NO. 14

ANCOV FOR DAYS TO FLOWER VS DAYS TO MATURITY(X_1X_6)

S.N.	Source	d.f.	S.P.	M.S.P.	F ratio
1.	Replication	3	10.84615	3.61538	4.7163
2.	Treatment	12	505.51923	42.12660	54.9554
3.	Error	36	-27.59615	-0.76656	
Total		51	488.76923		

TABLE NO. 15

ANCOV FOR DAYS TO FLOWERS VS NO. OF SEED PER SPIKE(X_1X_7)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	92.53500	30.84500	17.4033
2.	Treatment	12	168.58192	14.04849	7.9264
3.	Error	36	63.80500	1.77236	
Total		51	324.92192		

TABLE NO. 16

ANCOV FOR DAYS TO FLOWERS VS 100 SEED WEIGHT(X_1X_8)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	0.88231	0.29410	94.2628
2.	Treatment	12	-35.26846	-2.93904	942.000
3.	Error	36	-0.11231	-0.00312	
Total		51	-34.49846		

TABLE NO. 17

ANCOV FOR DAYS TO FLOWER VS YIELD PER PLANT(X_1X_9)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-6.13846	-2.04615	4.0699
2.	Treatment	12	-48.45692	-4.03808	8.032
3.	Error	36	18.09846	0.50274	
Total		51	-36.49692		

TABLE NO. 18

ANCOV FOR HEIGHT OF PLANT VS NO.OF TILLERS/PLANT.(X_2X_3)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	34.38154	11.46051	181.2224
2.	Treatment	12	3.70731	0.30894	4.8852
3.	Error	36	-2.27654	-0.06324	
Total		51	35.81231		

TABLE NO. 19

ANCOV FOR HEIGHT OF PLANT VS NO. OF SPIKES/PLANT(X_2X_4)

S.N.	Source	d.f.	S.P.	M.S.P.	Fratio
1.	Replication	3	52.8450	17.61500	79.3182
2.	Treatment	12	-11.5450	-0.96208	4.3321
3.	Error	36	-7.9950	-0.22208	
Total		51	33.3050		

TABLE NO. 20

ANCOV FOR HEIGHT OF PLANT VS LENGTH OF SPIKE(X_2X_5)

S.N.	Source	d.f.	S.P.	M.S.P.	F ratio
1.	Replication	3	44.48769	14.82923	37.1932
2.	Treatment	12	137.60190	11.46683	28.7598
3.	Error	36	14.35356	0.39871	
Total		51	196.44315		

TABLE NO. 21

ANCOV FOR HEIGHT OF PLANT VS DAYS TO MATURITY. (X_2X_6)

S.N.	Source	d.f.	S.P.	M.S.P.	F ratio
1.	Replication	3	47.97308	15.99103	13.1213
2.	Treatment	12	-195.18846	-16.26571	13.3467
3.	Error	36	-43.87308	-1.21870	
Total		51	-191.08846		

TABLE NO. 22

ANCOV FOR HEIGHT OF PLANT VS 100 SEED WEIGHT (X_2X_3)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-236.8541	-78.95137	50.6878
2.	Treatment	12	167.1379	13.92816	8.9445
3.	Error	36	-56.0579	-1.55716	
Total		51	-125.7741		

TABLE NO. 23

ANCOV FOR HEIGHT OF PLANT VS 100 SEED WEIGHT (X_2X_3)

S.N.	Source	d.f.	S.P.	M.S.P.	F.
1.	Replication	3	-0.76404	-0.25468	2.4353
2.	Treatment	12	12.44567	1.03714	9.9171
3.	Error	36	3.76779	0.10458	
Total		51	15.44642		

TABLE NO. 24

ANCOV FOR HEIGHT OF PLANT VS YIELD/PLANT(X_2X_9)

S.N.	Source	d.f.	S.P.	M.S.P.	F ratio
1.	Replication	3	31.32769	10.44256	31.5742
2.	Treatment	12	17.15835	1.42986	4.3233
3.	Error	36	-11.90619	-0.33073	
Total		51	36.57935		

TABLE NO. 25

ANCOV FOR NO. OF TILLERS/PLANT VS NO. OF SPIKE/PLANT(X_3X_4)

S.N.	SOURCE	d.f.	S.P.	M.S.P.	F
1.	Replication	3	9.39692	3.13231	10.3615
2.	Treatment	12	17.25000	1.4375	4.7594
3.	Error	36	10.87308	0.30203	
	Total	51	37.52000		

TABLE NO. 26

ANCOV FOR NO. OF TILLERS/PLANT VS LENGTH OF SPIKE(X_3X_5)

S.N.	Source	d.f.	S.P.	M.S.P.	F.
1.	Replication	3	6.90031	2.30010	20.5992
2.	Treatment	12	3.48385	0.29032	2.6000
3.	Error	36	4.01969	0.11166	
	Total	51	14.40385		

TABLE NO. 27

ANCOV FOR NO. OF TILLER/PLANT VS DAYS TO MATURITY (X_3X_6)

S.N.	Source	D.F.	S.P.	M.S.P.	F
1.	Replication	3	10.53846	3.51282	11.6677
2.	Treatment	12	1.23846	0.10321	0.3428
3.	Error	36	-10.83846	-0.30107	
Total		51	0.93846		

TABLE NO. 28

ANCOV FOR NO. OF TILLERS/PLANT VS NO. OF SEED PER SPIKE(X_3X_7)

S.N.	Source	D.F.	S.P.	M.S.P.	F
1.	Replication	3	-49.83369	-16.61123	134.8423
2.	Treatment	12	-8.27765	-0.6898	5.5595
3.	Error	36	-4.43481	-0.12319	
Total		51	-62.54615		

TABLE NO. 29

ANCOV FOR NO. OF TILLER/PLANT VS 100 SEED WEIGHT(In Gms.) (X_3X_8)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	0.21554	0.07185	12.5174
2.	Treatment	12	3.56308	0.29692	51.7282
3.	Error	36	0.20646	0.00574	
Total		51	3.98508		

TABLE NO. 30

ANCOV FOR NO. OF TILLER/PLANT VS YIELD/PLANT(In Gms) (X_3X_9)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	4.15446	1.38482	4.6525
2.	Treatment	12	21.55615	1.79635	6.0351
3.	Error	36	10.71554	0.29765	
Total		51	36.42615		

TABLE NO. 31

ANCOV FOR NO. OF SPIKES/PLANT VS LENGTH OF SPIKE(X_4X_5)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	9.64431	3.21471	43.4252
2.	Treatment	12	4.41450	0.36787	4.9692
3.	Error	36	2.66519	0.07403	
Total		51	16.72400		

TABLE NO. 32

ANCOV FOR NO. OF SPIKES/PLANT VS DAYS TO MATURITY(X_4X_6)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	12.00769	4.00256	13.9793
2.	Treatment	12	2.40000	0.2000	0.6985
3.	Error	36	-10.30769	-0.28632	
Total		51	4.10000		

TABLE NO. 33

ANCOV FOR NO. OF SPIKES/PLANT VS NO. OF SEED/SPIKES(X_4X_7)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-78.26212	-26.08737	103.661
2.	Treatment	12	2.8530	0.23775	0.9447
3.	Error	36	9.05962	0.25166	
Total		51	-66.3495		

TABLE NO. 34

ANCOV FOR NO. OF SPIKES/PLANT VS 100 SEED WEIGHT (X_4X_8)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	0.12331	0.04110	4.8928
2.	Treatment	12	1.79600	0.14967	17.8178
3.	Error	36	-0.30231	-0.00840	
Total		51	1.61700		

TABLE NO. 35

ANCOV for no. of spikes/plant VS yield/plant(X_4X_9)

S.N.	Source	d.f.	S.P.	M.S.P.	F.
1.	Replication	3	6.45169	2.15056	7.7225
2.	Treatment	12	20.07500	1.67292	6.0073
3.	Error	36	10.02531	0.27848	
Total		51	36.55200		

TABLE NO. 36

ANCOV FOR LENGTH OF SPIKES VS DAYS TO MATURITY(X_5X_6)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	11.45769	3.81923	19.948
2.	Treatment	12	-4.25577	-.35465	1.8523
3.	Error	36	-6.89269	-.19146	
Total		51	0.30923		

TABLE NO. 37

ANCOV FOR LENGTH OF SPIKES VS NO. OF SEED/SPIKE (X_5X_7)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-44.34445	-14.78148	89.662
2.	Treatment	12	107.60612	8.96718	54.396
3.	Error	36	5.93465	0.16485	
Total		51	69.19632		

TABLE NO. 38

ANCOV FOR LENGTH OF SPIKE VS 100 SEED WEIGHT(In gms) (X_5X_8)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	0.03092	0.01031	0.6517
2.	Treatment	12	-.28919	-.02410	1.5234
3.	Error	36	.56941	0.01582	
Total		51	0.31114		

TABLE NO. 39

ANCOV FOR LENGTH OF SPIKES VS YIELD/PLANT (In Gms.) (X_5X_9)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	5.51502	1.83834	13.6406
2.	Treatment	12	6.79868	0.56656	4.2039
3.	Error	36	4.85178	0.13477	
Total		51	17.16548		

TABLE NO. 40

ANCOV FOR DAYS TO MATURITY VS NO. OF SEED/SPIKES (X_6X_7)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-61.62654	-20.54218	27.447
2.	Treatment	12	79.49223	6.62452	8.8512
3.	Error	36	-26.94346	-.74843	
Total		51	-9.07577		

TABLE NO. 41

ANCOV FOR DAYS TO MATURITY VS 100 SEED WEIGHT ($X_6 X_8$)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	0.65769	0.21923	2.4605
2.	Treatment	12	-9.42462	-78538	8.8146
3.	Error	36	-3.20769	-.08910	
Total		51	-11.97462		

TABLE NO. 42

ANCOV FOR DAYS TO MATURITY VS YIELD/PLANT($X_8 X_9$)

S.N.	Source	d.f.	S.P.	M.S.P.	F
1.	Replication	3	5.69692	1.89897	8.768
2.	Treatment	12	-15.24923	-1.27077	5.8674
3.	Error	36	-7.79692	-.21658	
Total		51	-17.34923		

TABLE NO. 43

ANCOV FOR NO. OF SEED/SPIKES VS 100 SEED WEIGHT (X_7X_8)

S.N.	Source of c.variance	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-1.61630	-.53877	1.7748
2.	Treatment	12	-34.33948	-2.86162	9.4265
3.	Error	36	10.92848	0.30357	
Total		51	-25.02731		

TABLE NO. 44

ANCOV FOR NO. OF SEED/SPIKE VS YIELD/PLANT (X_7X_9)

S.N.	Source of c.variance	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-28.28602	-9.42867	3.8842
2.	Treatment	12	-38.56767	-3.21397	1.324
3.	Error	36	87.38857	2.42746	
Total		51	20.53488		

TABLE NO. 45

ANCOV FOR 100 SEED WEIGHT VS YIELD/PLANT (X_8X_9)

S.N.	Source of Variance	d.f.	S.P.	M.S.P.	F
1.	Replication	3	-.12180	-.04060	0.3493
2.	Treatment	12	11.18666	0.93222	8.0205
3.	Error	36	4.18440	0.11623	
Total		51	15.24926		

TABLE NO. 46

TREATMENT MEANS FOR DIFFERENT CHARACTERS IN WHEAT.

No. of Treat-ments	1 Days to flower-ing	2 Height of plant	3 No. of tiller per plant	4 No. of spike per plant	5 Length of spike	6 Days to maturi-ty	7 No. of seed per spike	8 100 seed weight	9 Yield/plant
1.	82.500	99.000	6.400	5.700	10.285	124.500	46.530	4.325	11.175
2.	71.500	84.550	6.350	5.850	8.513	120.000	45.910	3.740	11.015
3.	79.750	95.075	8.050	7.600	10.848	125.000	52.300	3.763	13.065
4.	67.00	93.550	6.750	5.800	10.055	122.750	47.865	4.400	11.730
5.	70.250	95.450	6.550	5.700	8.970	122.750	47.260	4.200	12.205
6.	76.500	89.950	8.300	7.400	9.230	123.500	44.090	4.700	13.700
7.	77.250	102.750	6.900	6.200	9.850	121.500	47.470	3.950	12.855
8.	83.500	91.900	7.050	6.200	8.020	127.500	39.855	4.150	11.990
9.	80.250	96.100	6.650	5.950	9.650	124.000	43.830	3.488	10.425
10.	72.500	99.000	7.300	6.550	8.495	120.250	44.302	3.950	10.905
11.	76.000	104.950	7.150	6.300	11.140	119.500	47.535	4.238	12.100
12.	83.000	90.500	6.400	5.850	9.915	126.750	51.203	3.650	10.700
13.	83.500	97.500	6.950	6.150	9.860	126.500	52.788	3.563	10.600
G.T. Means	77.1923	95.1904	6.9846	6.2500	9.6023	123.4231	47.3798	4.0088	11.7277

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